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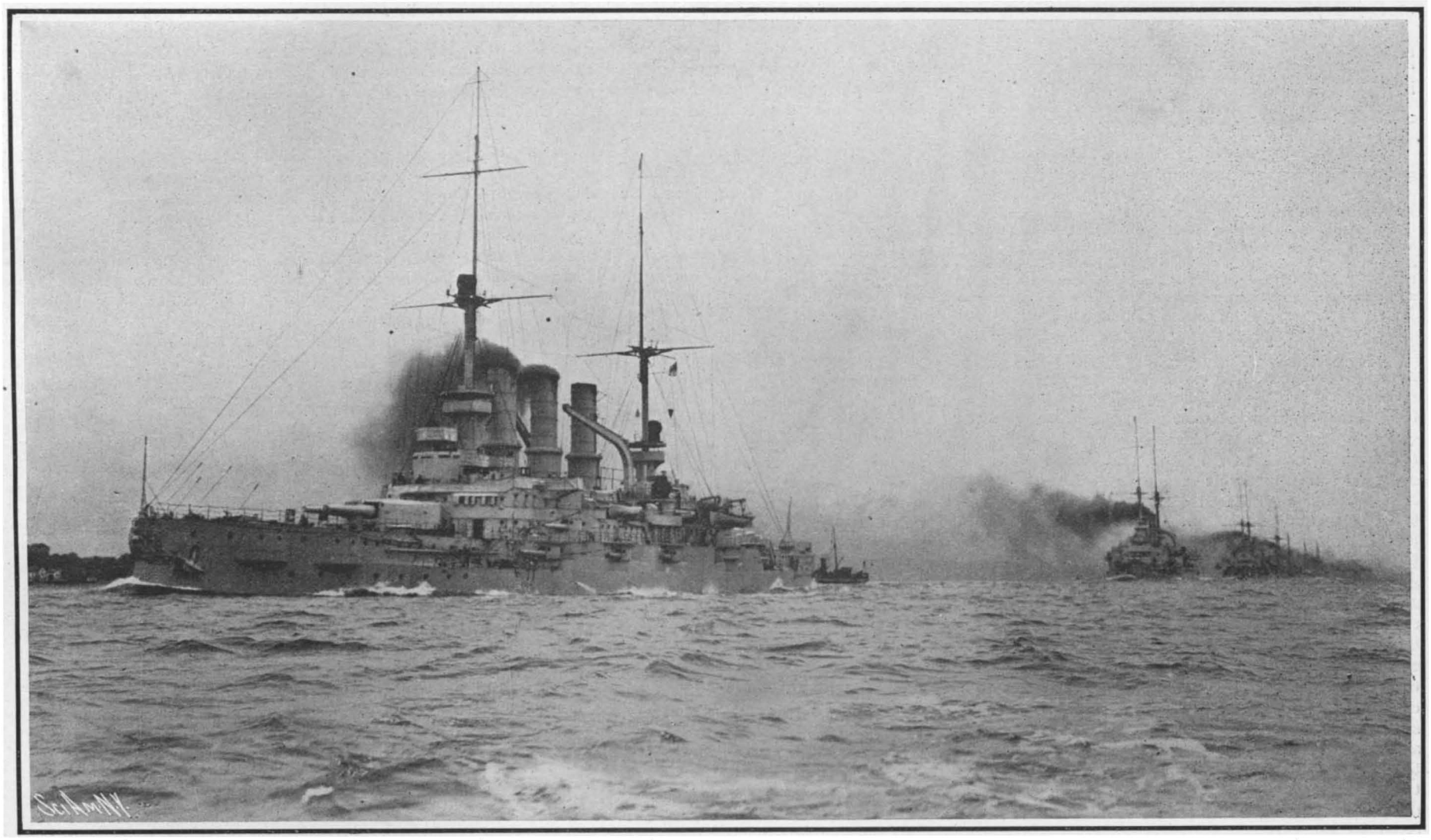
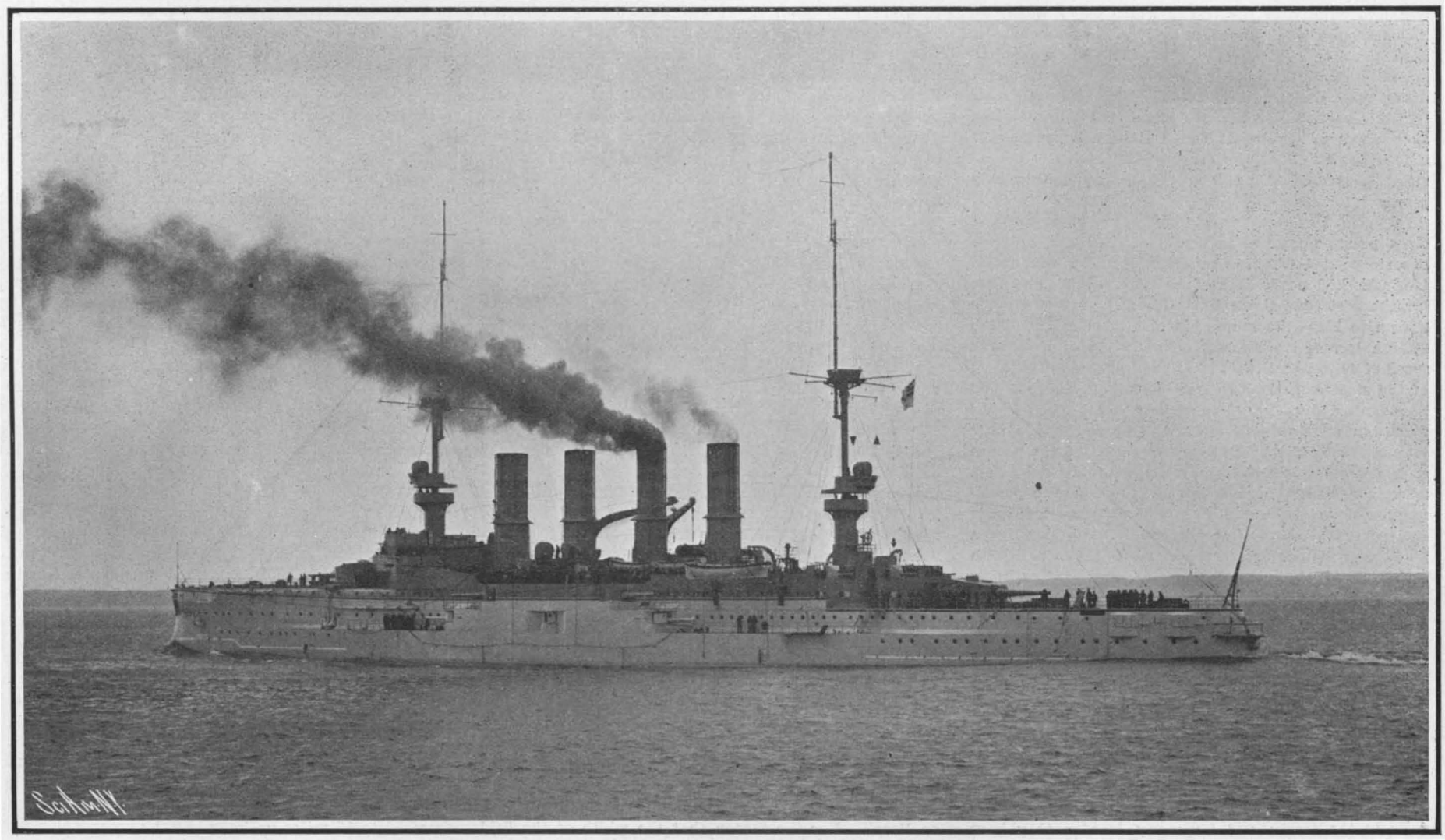


Displacement, 13,200 tons. **Speed,** 18.5. **Coal,** 1,800 tons, and oil. **Armor:** Belt, 9½ inches to 4 inches; deck, 3 inches; side, 8 inches; gun positions, 10 inches to 6¾ inches, **Armament:** Four 11-inch; fourteen 6.7-inch; twenty-two 3.4-inch; eight small guns. **Torpedo tubes,** six submerged. **Complement,** 736. **Date,** 1906.

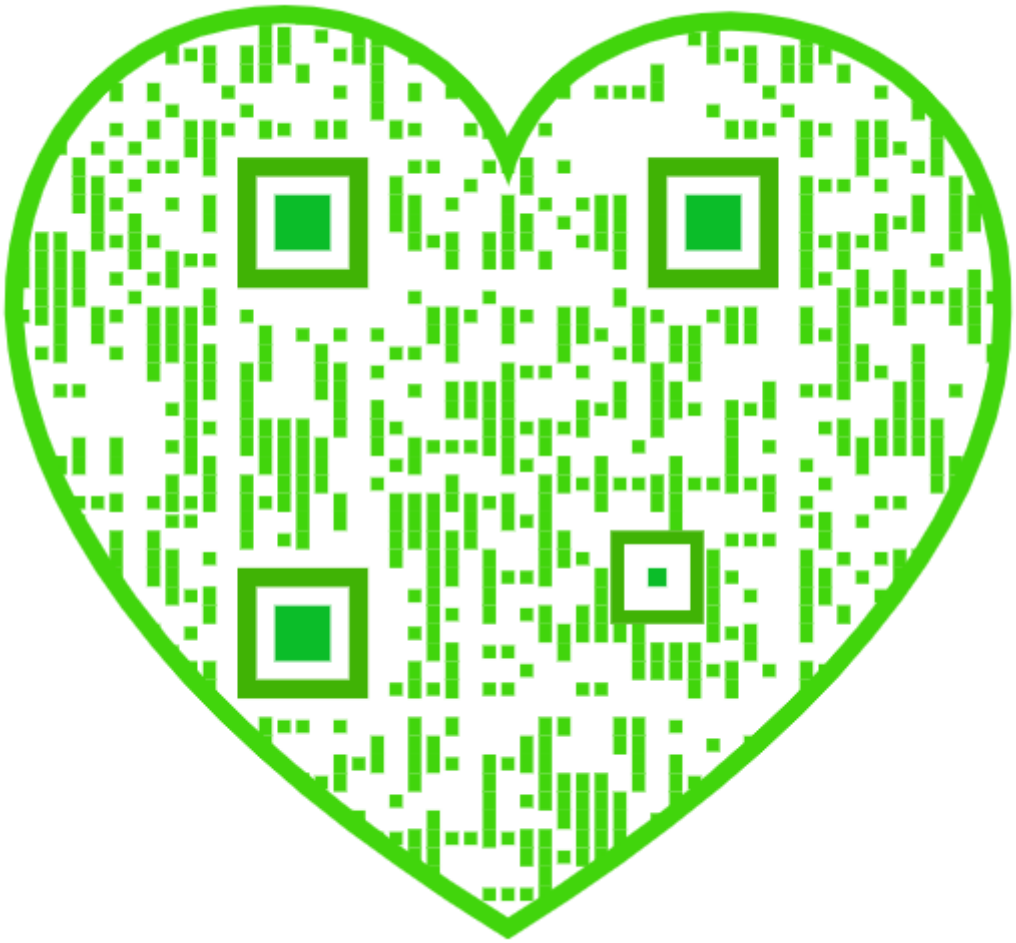
Battleship "Deutschland." Class of Five Ships.



Displacement, 11,600 tons. **Speed,** 22.5. **Coal Supply,** 2,000 tons. **Armor:** Belt, 6 inches to 4¾ inches; deck, 2 inches; side, 6 inches to 4¾ inches; gun positions, 6¾ inches. **Armament:** Eight 8.2-inch; six 6-inch; twenty 3.4-inch; twenty small guns. **Torpedo tubes,** four. **Complement,** 650. **Date,** 1908.

Armored Cruiser "Scharnhorst." Also "Gneisenau."

III.—THE GERMAN NAVY OF TO-DAY.—[See page 91.]



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NEW YORK, SATURDAY, AUGUST 8, 1908.

The Editor is always glad to receive for examination illustrated articles on subjects of timely interest. If the photographs are *sharp*, the articles *short*, and the facts *authentic*, the contributions will receive special attention. Accepted articles will be paid for at regular space rates.

THE RAILROAD SPIKE—AN ANACHRONISM OF THE TWENTIETH CENTURY.

In spite of the general excellence of the best modern American roadbed and track, with its deep broken-stone ballast, closely spaced ties, and heavy steel rails, it contains one important element, the railroad spike, which is so much out of date, so absurdly inadequate to the work it is expected to do, that it has no legitimate place to-day outside of a glass case in an American museum of railroad antiquities. The railroad spike was developed at a time in this country when the blacksmith's forge and anvil were more widely distributed and easier of access than the machine shop and the mechanic. The pioneer railroad builder in America built cheaply, not so much because he wished to as that perforce he had to; and when it came to the question of how to fasten the light 30-pound rail of the early thirties and forties down to the wooden ties, it was easily obvious that the quickest and the cheapest way was to *nail* it down; and so a nail or staple, with a hooked head, was forged on the anvil, and nailed down upon the tie with its hook clasping the base of the rail, in the hope that it would hold the two strips of iron in line and to gage, and prevent them from turning over under the lurching of the locomotive and cars.

Although nearly three-quarters of a century have passed, and each decade has seen a steady growth in the weight and speed of railroad trains and in the cost and quality of the tracks which carry them, we are still *nailing* the rails to the ties. Hence we do not hesitate to say that in the whole field of mechanical and civil engineering it would be impossible to find a device which is such an astounding anachronism as that miserable little piece of 5/8-inch-square iron known as the railroad spike, of which it may truly be said that it has absolutely no other qualifications to recommend it beyond that it can be cheaply made and quickly driven into place.

In proof of the above statement let us suppose it were possible that some first-class engineer, of wide experience and what we might call strong mechanical instincts, had never seen a modern railroad, and that for the first time the nature of a railroad were made known to him—the roadbed, track, steel rail, and the 200-ton locomotive hauling 60-ton Pullman cars at a speed of 60 to 70 miles an hour; and after the functions of the steel rail, the wooden ties, and the ballast had been explained to him, let us suppose that he were asked to design some suitable method of fastening said rails to said ties. After he had carefully studied the nature of the stresses to which the rails would be subjected, both in a vertical and a lateral direction, the pounding, bending, twisting, pulling, and pushing stresses, is it conceivable that he would draft out a plan for a little 5/8 or 3/4-inch-square spike or overgrown nail with a short hook at the head of it, and offer that as being quite adequate to hold the rail in position? It is safe to say that the spike, as we are using it to-day, is about the very last form of fastening that would commend itself to him. Rather, he would place his rail upon some form of metallic plate or chair, wedging or bolting it securely thereon; and this fastening itself he would bolt down to the tie, either by some form of heavy lag screw, or by bolts passing entirely through the tie and held by washers below and nuts above.

The builders of European railroads, taught by experience, realized long ago the absurdity of *nailing* the rails to the track; and for many decades they have been in the habit of either placing the rail in heavy chairs, triple-bolted to the track, or using heavy lag bolts, screwed down until the heads have drawn the base of the rail snugly down upon the tie. The English for many years have used a heavy cast-iron chair, with three or four bolts to the chair. Of late years the best type of American track includes a steel tie-plate, with two or three spike holes, one on the inside and two on the outside of the rail; and this device, apart from the increased bearing surface provided, has the advantage that before the rail can spread it must overcome the resistance of all the spikes that pass through the tie-plates. But, although this is a long step in advance, the spike still remains a poor contrivance, since the vertical springing of the rails under the passing traffic causes the rail base to partially pull the spikes and so decreases the security of the fastening. A combination of heavy lag screws with tie-plates would provide an ideal fastening for the flat-bottomed rail; and we observed, when examining the recent wreck of the White Mountain Express on the New Haven Railroad, that upon the local track adjoining that on which the wreck took place, the company has laid about a mile of experimental track of this character.

The wreck occurred on a track with two spikes to the tie and no tie-plate. The work of resisting the side sway of the locomotives fell upon the single outside spike, which proved, as it needs must, unequal to the task. But had that track been provided with tie-plates and lag screws, it is probable that the spreading would not have occurred. In justice to this road it should be stated that it is now engaged, and has been for some months, in tie-plating all the tracks on which the electric locomotive is used.

It will never be known what proportion of railroad accidents is due directly to the railroad spike. But probably nearly all the derailments that result from spreading of the track may be traced to this cause. We do not know of any feature of the physical characteristics of our railroads that is a more legitimate subject for investigation by such public bodies as the Interstate Commerce Commission and the Public Service Commission than this question of providing a rational means for fastening the rails to the track and holding them in true gage and alinement.

A TALK WITH HENRY FARMAN.

Henry Farman, the best known and most successful of the group of aeroplane experimentalists in Europe, has come to America under the auspices of the Aeronautical Society of America for the purpose of stimulating public interest in the aeroplane, by giving a series of exhibitions of flights in various parts of the United States.

The American public has long been familiar with Mr. Farman and his machine through the medium of the camera and the newspaper reporter. But there is a wide gap between the impressions received from the printed sheet and those gathered during an afternoon's trials, such as took place on Friday, July 31, in the presence of the Aero Club and its friends, preparatory to a public trial the following day, and the impressions of the man himself, as gathered by the writer of the present article during a *tete-a-tete* chat with Mr. Farman in his own private apartments later in the day. Mr. Farman's machine is so well known to the readers of the SCIENTIFIC AMERICAN through the many illustrated articles which we have published during the past ten months covered by his experimental work, that but little further description is necessary. It consists essentially of two planes, 6½ feet wide by 32 feet long, the one placed vertically above the other with a space of 5 feet between; a rudder for horizontal control, in front; and a box-shaped tail, 10 feet to the rear, in the center of which is the vertical rudder for lateral control and for the prevention of lateral oscillation. The box tail is the distinctive feature of Farman's machine, and to this contrivance is largely owing its remarkable stability and evenness of flight. At the center of the planes, and between them, is carried a 50-horse-power Antoinette engine, weighing about 400 pounds, which is a really beautiful specimen of the aeroplane motor builder's art. Farman sits on a low seat in front of the engine, with the steering-wheel shaft projecting horizontally forward, through two sleeves in which it rotates. Keyed on the shaft, just in front of the wheel, is a drum to which the wires that control the rudder in the box tail are attached. To turn the rudder to the right, the wheel is turned to the right, and *vice versa*. The steering shaft is free to slide axially in its bearings, and is capable of being pushed forward or drawn backward at the will of the operator. At the farther end it is pinned to an arm attached to the horizontal rudders, through which, by moving the shaft forward or drawing it back, the angle of the rudders, and the vertical course of the machine, may be controlled.

Mr. Farman is greatly hampered in his exhibitions in New York by the limited area of the field at Brighton Beach. For the reason that the width of the field is not sufficient to admit of turning at high speed, the flights must all be straight-away. Though the first trial flight, which took place on July 31, was short, it made a decided and very favorable impression upon those who witnessed it. When the motor was started, the machine gathered headway, slowly at first, and then very swiftly, the aeroplane running on its four pneumatic-tired bicycle wheels. The tail lifted first very soon after the start. When a speed of about 25 miles an hour was reached the forward wheels very gradually left the ground, and the machine, at an elevation of about 20 feet above the ground, ran in a perfectly horizontal line, and without the least deviation, either longitudinally or laterally, until the power was shut off. It then alighted on an even keel and ran along for possibly 100 yards before it came to a stop. Under the conditions existing on that afternoon, with a wind of about 5 miles strength blowing diagonally across the grounds, the aeroplane gave evidence of being under perfect control. During Farman's stay in America the length of the flights, under fairly favorable atmospheric conditions, will be limited only by the size of the grounds and the capacity of the fuel tank. At its present stage of development, the aeroplane is so delicate a fabric that a smooth and level landing place is an absolute necessity; but given this, and a large enough field, and the present machine, according to Mr. Farman, would be capable of a two and one-half hours' flight at a speed of over 40 miles an hour.

When we bear in mind that Farman's practical experimentation commenced less than a year ago, or on September 1, 1907, his success has been phenomenal. On that day he first succeeded in getting off the ground, making a short flight of 20 yards. His first flight of any distance was made on November 21, when he covered 770 yards; and his longest flight was made when he won the French prize offered for the first machine that would stay in the air for twenty minutes. This successful flight, which occurred shortly before his start for America, was a notable performance. He was in the air for twenty minutes and twenty-five seconds, and flew in a circle of a little over a mile circumference, covering about 14 miles at a speed of over 40 miles an hour. The flight was terminated only by the exhaustion of his gasoline and oil supply. With his 9-gallon tank aboard, Farman is confident that he could remain in the air for two and one-half hours, completing a trip of 100 miles at a speed of 40 miles an hour; unless indeed the flight should be shortened by those motor troubles which are liable to happen in any form of gas-driven locomotion.

Farman, the man, has a decidedly interesting personality; and, although he is an artist by profession, it required but a few moments' conversation to realize that he possesses the essential qualities of the successful engineer and inventor to an unusual degree. The inventor should have a strong dash of the imaginative quality; but to be a sucessful inventor, this quality should be mated to a keen logical and discriminative faculty. The most successful engineers have been those who possessed in a strong measure the ability to pick out the essentials from the non-essentials, and Mr. Farman is gifted with this quality to an unusual degree. In his brief but brilliant career in aeronautics, he has always maintained a firm grasp upon the fundamental principles which govern successful aeroplane flight. His realization of the absolute necessity for stability led him to adopt his large box tail, and he did this, although he was well aware that it involved increased weight and air resistance, and a somewhat slower response to control than is possible in the tailless type as used by the Wright brothers. For the same reason he uses large surfaces, larger than are actually necessary, and as a result he possesses to-day the steadiest flying machine in existence. Lateral oscillation is counteracted by the use of the box-tail rudder. If the right wing is lifted by a puff of wind the rudder is thrown over to the right, the machine is "thrown into the wind," as a yachtsman would express it, and the aeroplane returns to the level position. The action is not so quick as that secured by the use of separate controllable tips to the ends of the planes, as used in the "June Bug," or by springing the planes, as in the Wright brothers' machine. In this respect the box-tail type is, perhaps, inferior. It is Farman's intention to experiment with the controllable wing tips and use them in connection with his rudder, gradually reducing the size of the latter, until, if it be found advisable, the tail may be eliminated altogether. This is a conservative method of development, which is in keeping with the policy which has governed all of his experimental work.

In the short trial trips of Friday afternoon, Farman made a speed through the air of about 35 miles an hour. In his longer flights he has made speeds through the air of over 50 miles an hour. The Wright brothers have driven their 900-pound machine with a 25-horse-power engine at 42 miles an hour, and Farman's claim that he has driven his 1,100-pound machine, with an engine of twice the horse-power, at from 50 to 55 miles an hour is not unreasonable.

Langley, in his investigations of the principles of the aeroplane, showed several years ago that the higher the speed, the less the supporting surface required; and Mr. Farman's experience in driving at

his highest speed, has so fully confirmed Langley's investigations, that in his next machine he will cut down the width of his planes from 6½ feet to 3 feet, and greatly reduce the size of his box tail and of his horizontal rudders. With this machine he confidently expects to make speeds from 60 to 70 miles an hour. He believes that ultimately we shall come back to the model of the bird; the aeroplane of the future consisting of a single plane and a tail of moderate dimensions. Farman believes that with a machine of this type a speed of 100 miles an hour would be entirely practicable, and that we shall see this speed realized within the next two or three years.

CLOTHING FOR THE TROPICS.

The question of devising a suitable fabric for wearing apparel suitable to tropical climates, which shall shield the wearer from the actinic rays of the sun, is one that has occupied conspicuous attention during recent years. A thin white material is generally selected for this purpose, preferably "white duck"; and although it promotes a certain degree of coolness and comfort, it does not succeed in fulfilling healthy conditions. Discriminating Nature has provided the native in the torrid belt with an effective protection against the sun in a skin pigmentation which absorbs the actinic rays, so that their dangerous effects upon the constitution are counteracted. Consequently, the native is able to continue his labors without the slightest signs of fatigue during the hottest time of the day, when the white man is practically prostrated, or at any rate refrains from carrying out his duties from motives of self-preservation.

Investigation has shown that the piercing actinic rays striking the neck and back exercise a highly dangerous effect upon the spinal column and the nerve centers, which react upon the organs of the stomach, promoting such maladies as indigestion, which in turn react upon the brain, and in time completely undermine the physical condition of the body, until at last collapse results. Experiments have proved that if only the natural pigmentation of the native is artificially produced in the clothing of the white man, he experiences no more harmful effects than the former, since the long or heat rays in themselves are quite innocuous, so far as effect upon the constitution is concerned. The degree of protection secured by pigmentation has been decided by practical investigation, and it was found to have strong absorption qualities in regard to the actinic or short rays, the degree of pigmentation being proportionate to the intensity of the light prevailing in the native's accustomed environment. A thin layer of the skin was obtained, and the spectrum of an electric arc between two iron poles photographed after the rays had passed through the layer. It was found that the dark brown skin of the Hindoo entirely absorbed all the rays of shorter length than 3,600. From the result of these observations, it is obvious that the white man when in the tropics should wear black, red, or orange colored clothing owing to its preventing the passage of the short rays.

The white man, however, has a strongly developed aversion to wearing aught but white clothing, but this offers no protection whatever to the harmful actinic rays. Numerous efforts have been made to provide a non-actinic backing to such material, but the disadvantage to such a fabric is that its weight and thickness are unduly increased.

Recently, however, a British inventor has succeeded in devising a process in which the non-actinic material or threads are interwoven with the white and other colored surface of the textile and in such a manner that while the weight and thickness of the cloth are not increased, no evidences of the red material are observable on its external surface. The prevention of the threads of the red material penetrating the outer face proved the most difficult task, but this has now been successfully attained. The fabrics, to which the distinctive name "Solaro" has been applied, are either of wool, or cotton, or mixed, the former being most preferable for cold or moist climates, and the cotton where a dry heat prevails.

By means of this invention, the resident in the tropics has the same facilities in the choice and patterns of textiles for clothes as those living in temperate climes. All the various cloths and latest fashionable styles can be reproduced in "Solaro" with perfect success and comfort, and the facility is already much appreciated, as it enables one to secure a welcome relief to the monotonous white. Moreover, the material is also shower-proof and has a remarkable capacity for resisting heavy thunderstorms, mists, and so forth. Waterproofing is not secured by means of rubber or chemical solution, but is due to a secret process in the manufacture of the yarns employed. In this way there is no interference with the ventilation of the cloth. Although an excellent sun-repellent fabric, it is equally applicable for winter wear, while it has a high standard of durability. It is suitable for all external garments for either sex, and it compares in price with the best qualities of cashmere. Its hygienic properties have been fully appreciated by the examining board of the British Institute of Hygiene, while, moreover, it is sealed at the British Colonial Office for officers appointed to the tropics.

THE JAPANESE EXPOSITION.

In reply to a communication concerning the protection of patents, trade-marks, and designs of Americans participating in the grand exhibition of 1912, Consul-General Henry B. Miller transmits the following comunication from the director-general of the exhibition:

According to the provisions of the present patent law, article 15; the design law, article 22; models of utility law, article 20, and trade-mark law, article 20, when notice is given to the patent office, before installing such articles in the exhibition, if application for patent or registration has been made within six months from the day of receipt of said article at the exhibition, such application shall have the same validity as if it had been filed on the same day as the original notice. From this it will be seen that there will be no danger for any invention, installed in the exhibition, to be regarded as "publicly known," which on that account will properly insure the right of the inventor, while with regard to designs, models of utility, and trade-marks, after one has given notice concerning them to the patent office, as aforesaid, he shall enjoy a prior right to them. So that by enforcement of these laws we feel that a proper protection for foreign exhibits is already assured. But in order to render the right of foreign exhibitors more secure, and also to make it easier for them to send articles for exhibition, the imperial government introduced in the present session of the Diet a bill bearing on the following heads, which has already passed the House of Representatives:

1. A person having an article which is to be exhibited at the Grand Exhibition of Japan, who applies for a patent on his invention or for registration for designs, models of utility, and trade-marks before installing the same, and obtains patent or registration afterward, shall have the same protection as if such exclusive right had been granted on the day when the installation was made.

2. According to article 38 of the present patent law, if the patentee, without proper reason, has not worked or exploited his invention in the empire within three years from the date of his patent, or discontinues working or exploiting the invention in the empire for more than three years, and has refused the offer of a third person to purchase or use the invention on reasonable terms, the director of the patent office may revoke such patent. But in case such patented articles are exhibited at the Grand Exhibition of Japan the patentee shall be regarded as if he had worked or exploited his patented invention in the empire during the time such articles are on exhibition.

3. In connection with the importation and exhibition of articles which are imported from foreign countries to be exhibited at the Grand Exhibition of Japan no suit prescribed in the laws and rules relating to patents, designs, models of utility, and trade-marks, or no prosecution can be brought against the exhibitor for infringement of the rights which are protected in said laws.

THE CALENDAR OF THE INHABITANTS OF VENUS.

At the April meeting of the British Astronomical Association, Capt. Grant read a very interesting paper on a subject which belongs to philosophy quite as much as to astronomy—the development of the idea of time and the evolution of the calendar from the most ancient epochs to the present day.

Although the fundamental division of time, the day, appears to us intuitive, we must remember that in the arctic regions the marking of this division is by no means easy. During several successive months the sun is either always below or always above the horizon and the only method—a very uncertain one—of distinguishing between day and night is to observe the times of high and low tide. We owe the months to the motions of the moon. To this day the Malays, Polynesians, and Australian aborigines reckon time exclusively by months and days.

The greater unit of time, the year, characterized by the regular succession of the seasons, has presented the greatest difficulties to exact determination, partly because the seasons are not sharply distinguished in some regions, partly because of the universal desire to establish among the year, month, and day simple relations which find no support in the facts of astronomy.

Mr. M. Maunder, in commenting on Capt. Grant's paper, remarked that the inhabitants of Venus, if there are any such, must find it extremely difficult to establish units of time. If Schiaparelli's theory is correct, and Venus always turns the same face toward the sun, the planet has no day, and the lack of a moon deprives it of a month. Finally, it has no year, for its axis of rotation is perpendicular to the plane of its orbit and the latter is almost circular.

The problem of the rotation of Venus is yet unsolved. Stefanik and Hansky conclude from their recent observations, made from the summit of Mont Blanc, that the planet rotates in its axis once in about 24 hours. This is the opinion that was generally held before the researches of Schiaparelli. Lowell, on the other hand, has brought forward fresh proof that Venus always presents the same face to the sun.

SCIENCE NOTES.

Dr. Flemming, of the German army, has been studying, by means of balloon voyages, the distribution of microscopic organisms through the atmosphere. He finds that the current assumption of the absence of germs from the upper strata is entirely erroneous, and that bacteria attain, and continue to live at, elevations of more than 13,000 feet. Nor does the number of bacteria diminish in proportion to the increase in elevation, as might be expected. On the contrary, it remains nearly constant for the first 1,600 feet. Within this limit the number is 12.9 per liter (365 per cubic foot) while from 1,600 to above 13,000 feet it averages 0.37 per liter (10.5 per cubic foot). The number of germs is affected by the duration of sunshine, but no effect due to rain or snow could be detected. It is a striking fact that the organisms found in the upper strata are chiefly of species that secrete pigment. This is probably an effect of sunlight, the pigment being secreted as a protection against ultra-violet rays, and is analogous to the darkening of the human skin on high mountains.

M. A. Duboin, of Paris, has lately discovered two new compounds, these being the iodo-mercurates of thorium and of aluminium. In the case of thorium, he applies the method which gave him the iodo-mercurates of a number of the metals. He dissolves iodide of thorium in water together with mercuric acid, at a low heat. On cooling, the liquor deposits mercuric iodide, and then a crystalline mass in which large crystals are formed after some time. These crystals form the new body which is the iodo-mercurate of thorium. They are very deliquescent and are at once changed in the air, turning to a red color. Analysis shows that the body has the formula ThI_4, $5HgI_2$, $18H_2O$. The leading property of this salt is its easy decomposition by water. Another new compound of the same series has also been formed by M. Duboin, this being the iodo-mercurate of aluminium. He indicated some time since that a saturated solution of mercuric iodide in a solution of aluminium iodide in the presence of dry air would deposit an oxy-iodide. He secured enough of this latter to be able to study its properties. Since that time the mother-liquor left to stand in a perfectly dry amosphere in the presence of anhydrous baryta, deposited crystals which had quite a different appearance. These are elongated prisms of a very great deliquescence, and he was only able to obtain a very small quantity of them in spite of the long time of the evaporation. Analysis gives them the formula AlI_3, HgI_2, $8H_2O$. This body dissolves in water without giving the least deposit of mercuric iodide, even after a long time. Its great deliquescence and the small amount obtained have prevented the author from making further researches as yet.

THE CURRENT SUPPLEMENT.

One outcome of the prevailing tendency in naval construction for the all-big-gun warship has been the evolution of a new type of light armament for the purpose of repelling torpedo attack. The latest weapon of this type has been designed by Vickers, Sons & Maxim, and is described and illustrated in the opening article of the current SUPPLEMENT, No. 1701. The action of turbine propellers is authoritatively discussed. C. Chabrié contributes an article on the electrolytical production of metallic sodium. The twenty-third installment of Prof. Watson's "Elements of Electrical Engineering" is published. The subject considered is that of switchboard arrangements. L. J. Lesh, who has done much experimenting on the action of plane surfaces in the air, contributes an article on the conditions of successful aeroplanes. A. Heaton tells how a thermometer can be made at home. W. F. Stanley contributes a most exhaustive paper on prehistoric man. The second installment of Austin B. Fletcher's paper on the construction of macadam roads is published. Notes on motor-car design are contributed by F. W. Lanchester. In view of the world-wide interest aroused by the Olympic games recently held at London, an article on the Olympic Games of Ancient Greece ought to prove of interest. The SUPPLEMENT publishes a most authoritative article by the late Watkiss Lloyd, who knew, perhaps, more about this subject than any other archæologist

OUR "NOTES AND QUERIES" COLUMN.

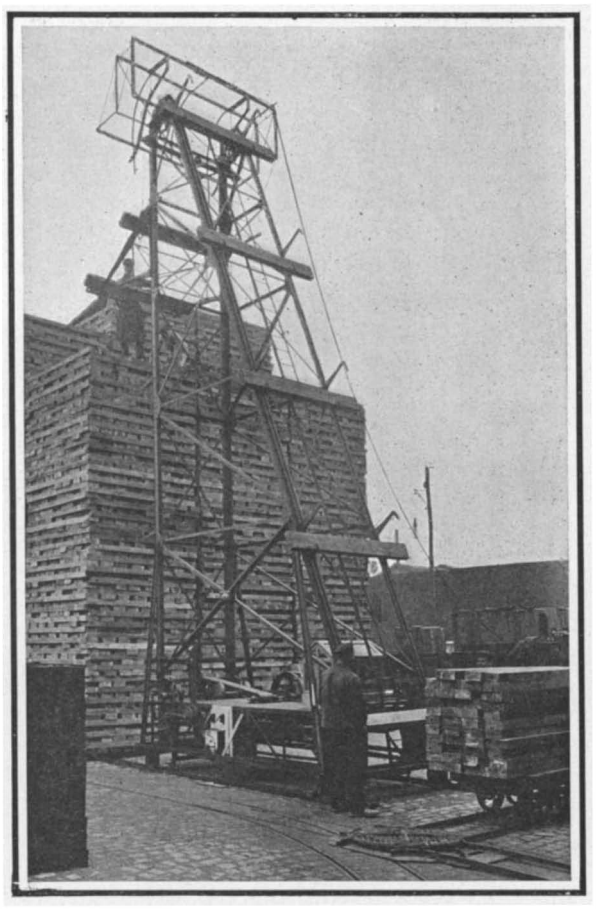
The attention of our readers is invited to the "Hints for Correspondents" which is published at the head of our "Notes and Queries" column in this issue. Considerable changes have been made, and a perusal of this notice will tend to prevent misconception as to the nature of our service.

A MACHINE FOR PILING TIMBER.

The operation of piling beams, logs, planks and railway ties is usually performed by hand. The piles are built up by successive stages. Many workmen are required and the work is not free from danger. Hence the new piling machine or elevator invented by M. Josse, the director of the municipal wood paving establishment of Paris, will be found very useful, for it solves very successfully a technical problem that has baffled the ingenuity of more than one inventor.

The machine, which is shown in operation in the accompanying photograph, consists mainly of two vertical triangular frames stiffened by cross braces. The frames are joined together, at each of the three angles, by an arbor bearing two toothed wheels which move two endless chains in vertical planes parallel to the frames. The chains carry, at regular distances, hooks for the reception and elevation of the logs, which are brought on cars to the foot of the machine. At the back of the machine are two pairs of inclined arms which can be raised vertically, as the pile increases in height, by means of a winch operated by a small electric motor. Two men, standing at the foot of the machine in front, lay the logs or beams, one by one, in the hooks attached to the lifting chains. When the log reaches the top of the machine it is tipped on to the two longer hooks which may be seen in advance of it. These long hooks, which are turned in a direction opposite to that of the lifting hooks, support the log in its descent down the back of the machine until it reaches the inclined arms. These arms receive the log from the hooks (which continue their downward course with the chains) and allow it to glide into the hands of a workman stationed on the pile. The man passes the log to his companions who lay it in its place.

The operation of the Josse machine is continuous and its employment makes possible a considerable reduction in the working force. It will probably be promptly introduced in all large timber yards.



THE JOSSE TIMBER-PILING MACHINE.

ARTIFICIAL SEA WATER.

BY THE ENGLISH CORRESPONDENT OF THE SCIENTIFIC AMERICAN.

One of the most complex problems that confronts the governing authorities of our great cities is the preservation of a clean bill of health in the quarters occupied by the poorer classes of the community. No matter how stringent the hygienic regulations may be, congestion and overcrowding are inevitable, and though the evils arising from this condition of affairs may be reduced to the minimum, the difficulties of the health officers are considerably enhanced by the ignorance of the population in even the rudiments of hygiene. The prevailing conditions not only favor a high mortality more noticeable among the infant population, but also constitute an excellent propagating ground for epidemical disease. Under these circumstances the medical officers of the boards of health have to maintain an unceasing vigilance, and resort to drastic measures to maintain healthy environment. This can be accomplished to a great extent by the liberal use of disinfectants both for street cleansing purposes and for use by the inhabitants, but unfortunately efforts in this direction are somewhat handicapped by the generally utilized antiseptic, carbolic acid, since the cost of the same is beyond the resources of the people, while free distribution entails a heavy charge upon the civic expenditure.

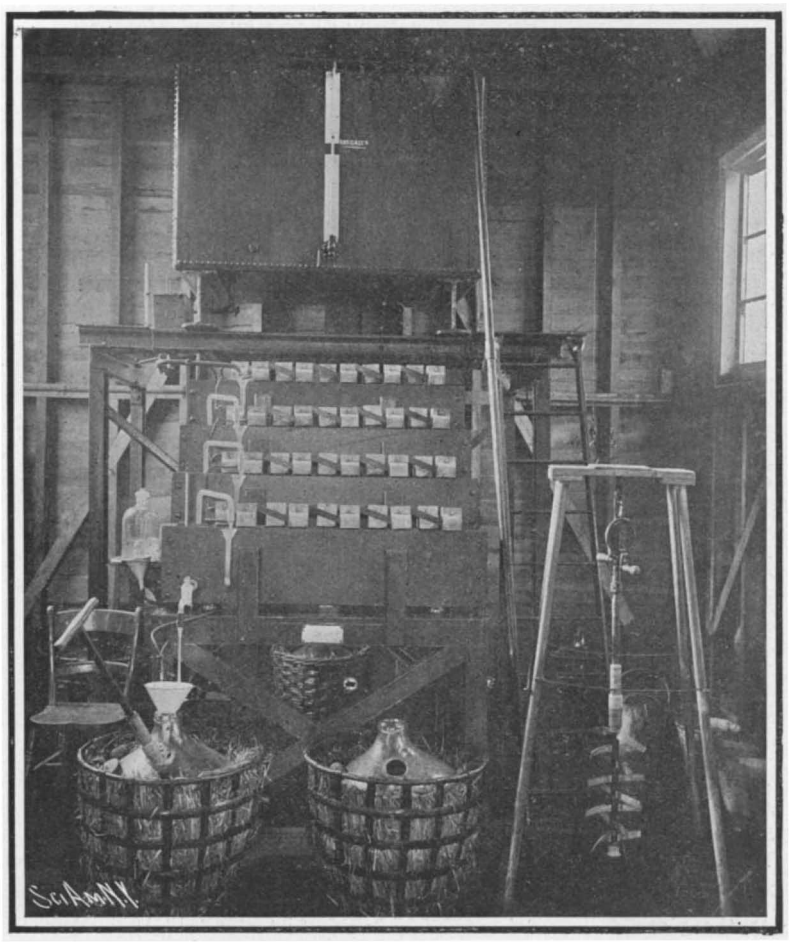
An eminently satisfactory solution of this problem, however, has been attained in the London borough of Poplar. Situated in the east end of London upon the northern low-lying bank of the river Thames, it is one of the poorest and most densely crowded areas of the English metropolis, the population of 170,000 being crowded within less than three square miles, and the density of population in one parish of 67,300 inhabitants averaging 111.23 persons per acre. With a view to increasing its healthy condition, which, despite its poor character, has always compared favorably with other metropolitan boroughs, Dr. Alexander, the medical officer of health, urged the liberal use of sea water as a disinfectant, the germicidal properties of which are well known. The natural product being unavailable, he advocated its synthetic production by electrolytic means as devised by Hermite, of Paris. The Hermite process which is in operation at Rolleville, near Havre, was inspected and being reported favorably a plant for the purpose was laid down in 1906.

The plant and process are both simple. There are two saturators containing respectively solutions of sodium chloride and magnesium chloride. The two solutions which are the fundamental constituents of natural sea water become combined in their correct proportions in a main tank at the top of the plant. Below this tank are disposed in descending rows, four double troughs or cells. Each trough is divided laterally by a partition and in each of the two divisions thus formed are five distinct elements comprising one positive and two negative plates. This represents ten cells to a trough, making 40 cells for the four rows. The positive plates are made of thin platinum wire wound upon slate slabs, while the negative plates are of zinc. The solution falls from the bottom of an elevated supply tank into a small ball valve supply cistern to secure steadiness of feed, and thence it passes through a glass funnel into the front division of the uppermost trough, flows throughout its length, doubles back through the rear division, and discharges over a small weir into a special subdivision. Into this extends one leg of a glass siphon, the other leg of which terminates in a funnel depending into the front division of the second trough. Through the latter the fluid again passes, repeating its course up the front, and down the rear, divisions, and being carried through another siphon and funnel into the third row of cells. The cycle of operations is continued until the fluid has passed through the four troughs and is discharged into a carboy. It will thus be seen that a continuous gravitation flow of the liquid is secured, the solution passing through forty cells before it enters the receiving carboy. During its passage the fluid is subjected to the action of a regulated current of 15 to 17 amperes at 230 to 250 volts, being from 5.7 to 6.2 volts per cell. On the left-hand side of the illustration is shown a small bottle, the discharge tube from which also enters the mouth of the carboy. This vessel contains magnesium hydroxide, which is used as a preservative; also this falls into the carboy drop by drop as it is charged. As the liquid runs into the carboy it is agitated by means of an ebonite rod fitted with a number of rubber flaps which mixes the electrolyzed sea water and magnesium hydroxide solution thoroughly together, thereby preventing any loss of chlorine. The agitator is placed in the carboy, which is of special design, through a second aperture in its neck. When the carboy is filled it is given a final stirring for about two minutes by the gear-driven stirrer with rubber flaps shown on the tripod to the right of the illustration.

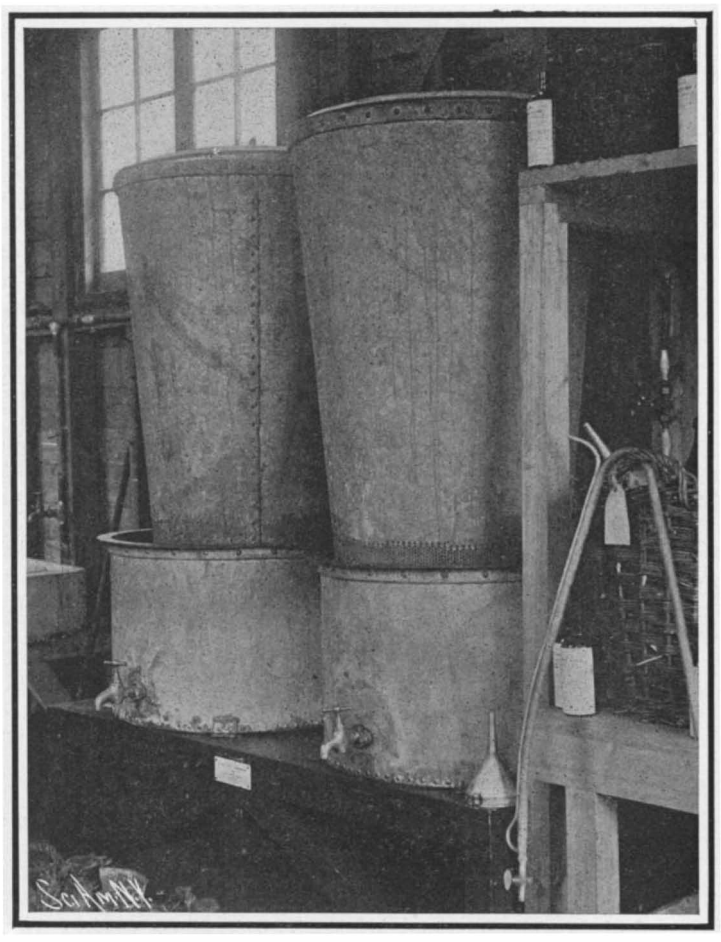
Before Dr. Alexander devised these stirrers the carboys when half and completely filled respectively, had to be given a thorough shaking for about ten minutes, since it is essential that the magnesium hydroxide should combine with the other constituents of the solution to render the latter fluid stable throughout. Unless this is done the precipitate falls to the bottom and the stability of the fluid is impaired. Hand shaking, no matter how thoroughly carried out, failed sometimes to bring about the required stability of the solution, but with the ebonite stirrer complete success in this direction is now attained. Since the photograph was taken a slight modification has been effected in the arrangement of the apparatus. After passing through the last cell the electrolyzed solution instead of falling direct into the carboy flows first into a small tank to combine with the preservative agent, magnesium hydroxide, which can be more efficiently combined therein, and thence to the carboy.

A thermometer is placed in the elevated supply tank and at the outfall from the last electrolyzing trough.

(*Concluded on page* 90.)



Apparatus for Electrolytically Producing Sea Water Disinfectant.



Saturators Containing Solutions of Sodium Chloride and Magnesium Chloride Respectively.

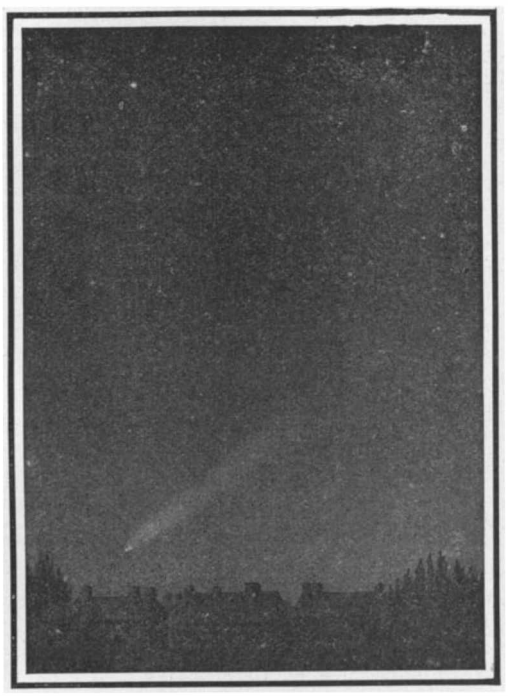
MANUFACTURING SEA WATER AS A DISINFECTANT.

THE MYSTERY OF COMETS.

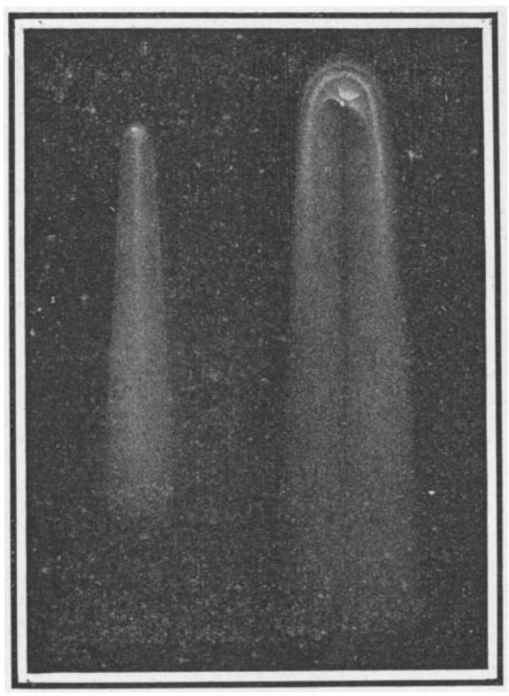
BY J. F. SPRINGER.

There is, perhaps, no other astronomical phenomenon capable of stirring the minds of the mass of mankind so profoundly as the apparition of a great comet. The psychologic effects of a total eclipse of the sun have at times been extreme. The same may be said of those wonderful displays of meteors in 1833 and 1866, when for a time it seemed as if all the stars were plunging, or were just about to plunge, upon the earth. But eclipses and meteoric showers are very transient, and whatever the consternation they inspire, it is soon past. A comet, however, may hold a huge and brilliant sword of fire in the sky for days and weeks—appalling the minds of men with the fear of some impending and inevitable catastrophe.

It may be said that the progress of science justifies the laying aside of apprehensions of calamity from this source. This is, in part, true. But not altogether. The probability of a collision is quite remote, it is true. Still it is within the range of possibility. It may be said that a collision would work no great effect. One justification for this lies in the fact that even the central portion of some comets appears to be extremely tenuous, permitting faint stars to be seen through thousands of miles of the cometary material. But this is not known to be a necessary attribute of comets in general. In fact, the mass of no comet has ever been accurately determined. So, for aught we know, there may be comets whose nuclei are not only large but massive. A collision with such a visitor from the abyss of space would be disastrous in the highest degree. The most striking thing about the typical comet is the appendage known as the tail. This is a streamer of light originating at the head and extending, in some cases in a straight line, in others in a curve, until lost in the depths of space. In fact, a single comet may have several tails at once. Thus the comet of 1744 possessed a multitude of tails differing from each other in curvature. A more recent case is that of Donati's comet (1858) which exhibited both straight and curved appendages, as may be seen in the engraving.



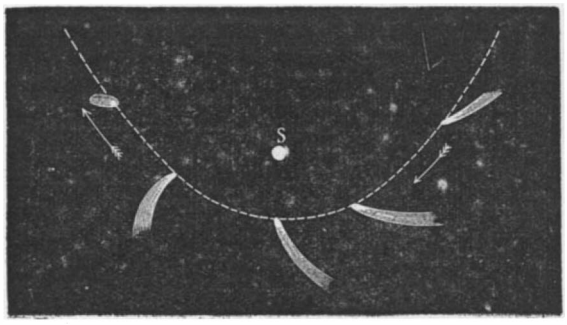
The Comet of 1882, as Seen from Streatham, November 4, 4 A. M.



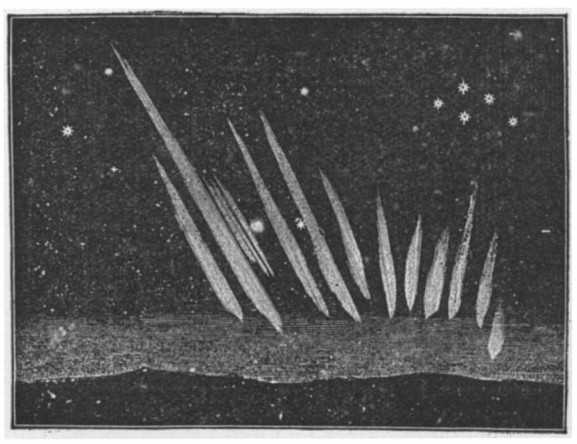
Coggia's Comet, as Seen on June 10 and July 1, 1874.

That the tail of a comet may be of enormous extent has been recognized from Newton's time. He calculated that the great comet of 1680 possessed at one time an appendage which stretched out into space the monstrous distance of 60,000,000 miles. This was exceeded, however, by the comet of 1811 with a tail of 100,000,000 miles and still further by the comet of 1843, which displayed a tail which possessed a length of 200,000,000 miles or more.

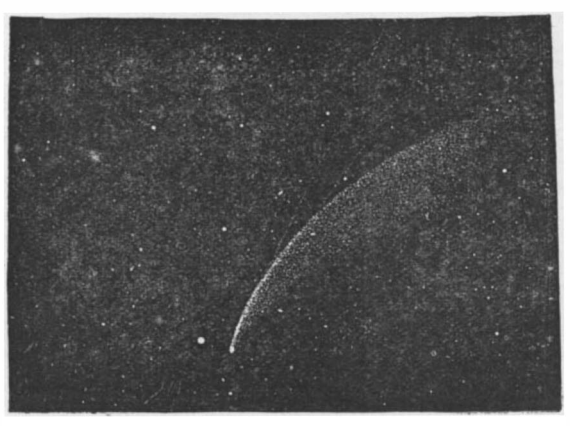
What are these tails? That has been a great mystery. They are not permanent. In fact, they only come into evidence during the period of comparative nearness to the sun. Some comets, indeed, seem never to attain to this distinction. Whatever the tail is, it would seem pretty clear that it cannot be a solid, or even a gaseous appendage which continues composed of the same material for even a moderately brief time. This will be readily granted when certain facts are weighed. In the first place, the tail always extends *away from* the sun. There may be a projection from the head in the direction of the sun. But this is comparatively of slight extent and is merely an additional phenomenon. Secondly, some comets have approached so near the solar surface and have been possessed of such incredible velocity at the time of close approach that their tails have been revolved through vast extents as the heads swung round our luminary. If we suppose that the tail is always of the same material, then in the case of a comet which has changed from approach to recession in the course of a few hours the exterior end of the tail has reached through space with a velocity that is beyond all reason. The comet of 1843 accomplished a complete reversal of its direction of movement in the short space of 131 minutes. That is to say, it swung its tail of



The Tail of a Comet is Always Directed Away from the Sun.



The Multiple-Tailed Comet of 1744.



Tails of the Comet of 1858.

The Two Views of Brook's Comet Superposed, One upon the Other, to Compare Deflection of the Tail.—Photographed by Barnard.

Brook's Comet on November 2, 1893. Note Direction of Tail.

Brook's Comet Twenty-four Hours Later; Tail Deflected 15 Degrees.

Photographed by Barnard.

say 100,000,000 miles through a semi-revolution in this time. This means that the particles at the end performed a journey of 314 million miles at the rate of 40,000 miles per second. This appears incredible, and besides, the disruptive effects of the centrifugal force set up would be such that no material would conceivably be able to endure them. The gigantic flywheel would surely burst. This difficulty has been more or less realized and felt by astronomers for a long time.

In fact, it must have been considerations of a similar character that led Kepler to propound at the beginning of the seventeenth century (1619) his theory of tail formation through repulsive action of the sun's light. Conceiving light to be due to the radiation of minute particles of matter, it was not at all preposterous to imagine that these corpuscles should sweep along with them material found in the comet itself and thus generate a tail. So long as the corpuscular theory of light was held, it was possible perhaps to maintain this view. But with the advent of the wave theory which teaches that light does not consist of material particles at all, but of waves of energy, the hypothesis of Kepler dropped from view.

In 1811 a very great comet appeared which awakened in the mind of Dr. Olbers, a distinguished amateur German astronomer, a very keen interest. Accordingly, he made a profound study of it, and proposed a theory to account for the phenomena connected with the tails of comets in general.

He conceived that an electric repulsion was set up between the comet and the sun arising from their comparative proximity. This would have the effect of driving off cometary particles in a direction away from the sun. Likewise he thought an electric repulsion would be generated between the nucleus and portions of its substance giving rise to one or more enveloping masses of material, thus explaining appearances observed in some comets. It seems possible that he was right in postulating electric repulsion as a cause at work in connection with comets. Another theory has, quite recently, come to the front which is scarcely able to furnish a complete explanation of all the observed phenomena. However, it seems not unreasonable to expect that all the facts may be accounted for between the two hypotheses.

That the tails are to be explained as somehow due to the sun has been evident to astronomers for very many years. Sir John Herschel perceived this very clearly. A couple of years ago (1905), Prof. E. E. Barnard pointed out this same requirement, expressing the view that a repellent influence of some sort proceeded from the sun. To this, however, he *added* two other requirements. Certain comets have, in addition to the main appendage which sweeps away from the head in the general direction of a line drawn from the sun to the comet, one or more smaller and *divergent* tails. For this he asks an ejecting force proceeding from the comet itself. Again, he thinks that at times some resisting influence in addition to repellent forces of the sun and comet must be postulated. Thus in Brook's comet of 1893 phenomena were present which pretty clearly demand the presence of some sort of resistance in the portion of space traversed. We publish herewith a view of this comet on November 2, displaying stars in the vicinity. The general direction of the tail corresponds pretty closely with the radius vector drawn from the sun through the comet's head. Another view shows the comet twenty-four hours later. The tail appears here as deflected about 15 deg. from the radius vector. The deflection was in a direction the reverse of that of orbital movement. A third view shows these views superposed, the stars of the two being made to correspond. The two positions may now be compared. The direction of orbital movement is from the lower to the upper. The tails should be approximately parallel, as the radius vector was changing its direction but slowly at the time. It is as if, in moving from the lower to the upper position, the tail had been retarded, especially at its outer extremity. Prof. Barnard conjectures that perhaps a stream of meteors was encountered. At the same time, he points out, as an alternative possibility, that some other current of retardation may be circulating about the sun of whose nature we are ignorant.

As to just what repellent influence may proceed from the sun and result in the formation of certain cometary tails, Prof. Svante Arrhenius, president of the Nobel Institution, has formulated a definite theory. More than thirty years ago Prof. Clerk Maxwell, the great Scotch physicist, arrived by means of mathematical considerations at the conclusion that rays of light do exert a pressure, notwithstanding their non-corpuscular character. The formula for the calculation of the amount of this light pressure shows that it is very feeble. But so is gravitation feeble when compared with molecular forces as we see them displayed in dynamite explosions. Prof. Arrhenius applies this light pressure to the generation of streams of matter flowing from the comet's head. In order to understand how it is that light may be conceived as driving away from the sun—in opposition to both the solar and the cometary gravitative influence—particles of the substance of the comet, while at the same time the comet itself is obedient to the solar control, it will be well to compare the two forces.

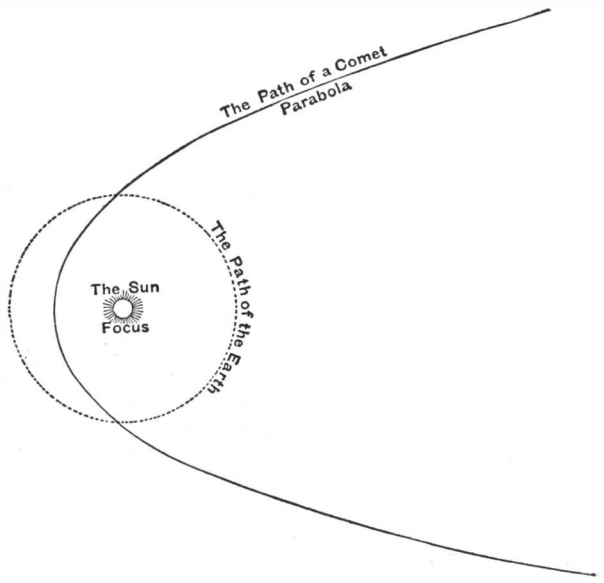
Gravitation acts on every particle of matter in a body, whether the particles be exterior or not. Light pressure, on the contrary, acts only upon the surface exposed to it. Thus, in the case of a cannon ball every minute particle whether in the interior or not feels the gravitative influence. But only the *surface* of the hemisphere turned toward the light feels the light pressure. And even this cannot be counted fully. In fact, only the amount of surface exposed perpendicularly to the light rays—that is, a circle of the same radius as the sphere. Suppose we take a ball whose radius is 4 inches. Its gravitation is so much. If now we decrease the radius to 2, then to 1, and so on, the gravitations of the balls will be proportional to

64, 8, 1, ⅛, 1/64, etc.

Now, the light pressure will be proportional to

16, 4, 1, ¼, 1/16.

It is evident that the first series is decreasing much more rapidly than the second, so that, whether light and gravitation exert absolutely the same strength of influence, we shall sooner or later arrive at a point, in gradually reducing the radius, where the gravitation is precisely equal to the light pressure. To go below this point is to have the light pressure exceed the gravitation. The result of a contest between the two for control of such small particles can only result in their being driven in the direction of the light radiation and against gravitation. Now this is what Prof. Arrhenius conceives to happen frequently in the case of comets. As the comet approaches the sun, his heat so acts upon the cometary substance as to produce quantities of exceedingly minute particles of such size as to be subject to control by the luminous rays from the sun in opposition to his gravitative influence. Consequently, multitudes of them are driven



The Parabolic Path of a Comet.

off in the direction of the radius vector and *away from* the sun. Light shining on this stream of infinitesimal bodies gives it the appearance of a luminous streamer.

This theory that light (and heat) exert pressure may seem almost incredible. And inquiry might justly be made whether there is any direct evidence to support it. In reply, it may be said that there is experimental corroboration of Maxwell's mathematical result.

Indeed, about the middle of the eighteenth century an experimental effort was made to determine whether light exerted pressure. The result was doubtful. But, in quite recent years, more successful experiments have been made. Lebedew, a Russian scientist, who was perhaps the first to suggest the light pressure of Maxwell as a cause of cometary tails, and the Americans Nichols and Hull have attacked this problem afresh and attained results confirmatory of the general proposition of the existence of a radiative pressure exerted by light rays. The accompanying illustrations, with the exception of the three photographs of Brook's comet, are reproduced from Sir Robert Ball's "Story of the Heavens."

According to the Electric Railway Review, experiments are being made under commercial conditions in Pittsburg, with a 5-ton electric delivery, which can be propelled either by its own batteries or, when running along tramway routes, by taking current from the overhead line by means of an ordinary trolley. The vehicle is provided with four 2½-horse-power motors, which are used in series on the trolley line or in parallel on the 42-cell battery. The gearing permits of a speed of 22 miles per hour when on the tramway track, which is fast enough not to interfere with the tramway traffic, and the battery can propel the car at 8 miles per hour. A smaller car on the same principle has been in use for parcel delivery for two years.

ARTIFICIAL SEA WATER.

(*Concluded from page* 88.)

The difference in the temperature readings of the two thermometers indicates the rise in temperature attributable to the electrolyzing action, which is found, when the apparatus is working properly, to be under 30 deg. F. The inclusion of the small feed tank is necessary to keep the flow into the electrolyzers constant. When the plant was first installed and without this subsidiary tank it was found that the fluid used to become unduly hot, owing to the reduction of the flow due to the decrease in head of the solution in the elevated tank.

The fluid in the large supply tank has to be agitated at frequent intervals in order that it may be kept at an even density throughout, more especially as a certain quantity of magnesium hydroxide solution is added. This end is fulfilled by means of a large galvanized iron plate freely perforated, normally resting upon the flooring of the tank, and connected at either end to chains passing over a pulley above the tank. When one end of this plate is lifted the other acts as the fulcrum so that the operator in order to stir the liquid has simply to pull either of the chains from a convenient point alongside the electrolyzer in order to keep the contents of the tank stirred.

Owing to the numerous modifications that have been effected and the elimination of complicated details in operation combined with the utilization of automatic action, the plant does not require any skilled attention. The Poplar installation is supervised by two intelligent workmen, whose duties comprise for the most part the stirring of the contents of the carboys during charging and their removal when filled, testing of the liquid from time to time, and general supervision to see that the apparatus is working, though owing to its simplicity breakdown is a very remote liability. The renewal charges are practically *nil* since the positive electrodes being of platinum are indestructible, while two years' constant wear of the zinc negative electrodes has failed to show any appreciable signs of wear, so that their renewal, provided proper attention is bestowed, is only requisite every few years.

When the plant was first installed great difficulty was encountered in preserving the stability of the disinfectant thus produced. For instance, the solution as it left the electrolyzer would show a proportion of 4.8 grammes of chlorine per liter, but immediately a deterioration in the quantity of chlorine would set up so that after a few hours the proportion of the former would only be 2 grammes per liter. The overcoming of this depreciation constituted one of Dr. Alexander's great problems, for obviously a disinfectant produced by this process which showed such a heavy drop in its efficiency was of little commercial use. The action of the electric current upon the combined solutions of sodium and magnesium chlorides decomposes the last-named chloride as well as the water. At the positive poles nascent chlorine and oxygen or ozone are formed which instantly combine and form an oxygenated compound of chlorine. This, though of great oxidizing power, is unstable, and is soluble in the fluid in which it is formed. The hydrogen set free by the decomposition of the water and the magnesium released at the negative pole results in a production of magnesium hydrate, part of which combines with the oxygenated chlorine compound, while the remainder rests in suspension in the tank. The sodium chloride acts as the conductor for the electric current. The chlorine compound solution obtained in this manner has only a slight smell of chlorine, in fact is nearly neutral, and its strength can easily be tested by the general arsenious acid test. In order to fix the chlorine Dr. Alexander carried out experiments with caustic soda added to the electrolytic solution, which resulted in the formation of a white precipitate hydroxide of magnesium which fell to the bottom of the carboy. He found that if the carboy were then well agitated this white precipitate became diffused throughout the fluid, giving it a milky appearance, and the more milky the liquid the more stable was it rendered. As a result of these investigations he adopted the principle already explained of adding a small quantity of magnesium hydroxide to the electrolyzed fluid as it falls into the carboy, thereby combining with the unstable oxygenated chlorine compound and converting them into a stable hypochlorite of magnesium which is stable for all practical purposes when kept in non-actinic bottles, well stoppered with paraffine corks and away from the light. By this simple addition of magnesium hydroxide well stirred in a milky fluid is gained and the surplus hydroxide magnesium having done its work sinks to the bottom.

During the two years the plant has been in operation 32,586 gallons of disinfectant have been produced with a strength ranging from 4 to 4.5 grammes of available chlorine per liter and at a manufacturing cost of about 4 cents per gallon.

The disinfectant is supplied to the members of the public in pint bottles from the various depots dis-

tributed throughout the borough, free of cost, and it is similarly furnished gratis to the various public institutions governed by the municipal authorities such as the sick asylums, workhouses, schools, public baths, hospitals, and so forth. Moreover, it is utilized for the flushing of the streets, market and other public places, for which purpose 13,656 gallons have been used during the past two years, the Works Department, to whom this duty is deputed, paying at the rate of 2 cents per gallon.

As an antiseptic it compares very favorably with carbolic acid. Immediately the fluid is brought into contact with such decomposing matter as meat, fish, fæces, or other decaying refuse, the evolution of chlorine is observed, and the loathsome odor attached to such decay disappears almost instantly and does not reappear if sufficient disinfectant is used. It is obvious, therefore, that after the first rapid reaction a slow continuous evolution of chlorine results so long as there is an excess of either oxidizable substances or hypochlorites. It is the presence of organic matter that sets the reaction going and commences the evolution of nascent chlorine.

The fact that the disinfectant is greatly appreciated by the inhabitants of the borough is evident from the huge bulk that is disposed of. Precisely what its introduction means to the economical advantage of the municipal authorities may be gathered from the great saving that has attended the introduction of the process in comparison with the cost of formerly distributing carbolic acid, which saving is now over $5,030 for the two years.

Rebuilding the Quebec Bridge.

The Canadian government, says the Iron Age, will assume all the assets and franchises of the Quebec Railway and Bridge Company under a resolution which will be introduced at Ottawa, and the reconstruction of the Quebec bridge will be undertaken as a government project, under the supervision of the Trans-Continental Railway Commission. The oversight of the construction work will be in the hands of a board of prominent engineers, one from Canada, one from the United States, and the third from Great Britain. It is stated that the Canadian government will assume the loss of all expenditures made by the Quebec Bridge Company under the bond issue guaranteed by the government up to the collapse of the bridge, the amount being between $5,000,000 and $6,000,000.

The Bells of the Metropolitan Tower.

A Westminster peal of bells weighing 7 tons is to be hung in the uppermost gallery of the great tower of the Metropolitan Life Insurance Building, which is now fast nearing completion in New York city. The gallery in question is on the forty-sixth floor. The bells will be placed between white marble pillars, against which the deep rich bronze of the bells will be visible. Instead of suspending the bells in the usual way upright supports will be used. Automatic clappers will strike the quarter hour. The largest of the bells will weigh 7,000 pounds, and will measure 70 inches across its mouth. It will be toned to B flat, and will be used to strike the hours as well as to take part in the general choir. The second bell, an E flat, will weigh 3,000 pounds; the third, an F natural, will weigh 2,000 pounds, and the fourth a G, will weigh 1,500 pounds. The bells will be rung at rather more than twice the height of any other peal in the world.

Concrete Railway Ties Not Found Satisfactory.

After years of thorough testing and experimenting, the officials of the Burlington Railroad have come to the conclusion that the use of concrete for ties is not satisfactory, and that the most satisfactory solution of the tie problem is to treat wood so that it will withstand the action of the elements. Accordingly they have decided to construct a large plant for treating ties, bridge timbers, etc., with creosote. This plant will be the largest and most complete of its kind in the world. It will cost about $270,000.

Transvaal Stope Drill Competition.

The Transvaal Chamber of Mines has forwarded a number of copies of the rules governing the stope drill contest to the American Institute of Mining Engineers. Those who desire to compete for the prizes can obtain copies of the results from the secretary of the Institute at No. 29 West 39th Street, New York.

According to a consular report the electric railway departments in the German electric works were very active during the year 1907. In the first place, Berlin and Hamburg gave them continuous occupation in the further extension of their elevated and underground railways. The Prussian State, which introduced electricity for the Hamburg suburban traffic, also became a customer. Bavaria, too, decided to apply electricity as a motive power for railway traction on the Berchtesgarden-Salzburg line.

III.—THE GERMAN NAVY OF TO-DAY.

Continuing our series of articles on the leading navies of the world, of which the first, on the American navy, was published on December 7, 1907, and the second, on the British navy, March 7, 1908, the present article deals with the German imperial navy, which, in point of strength and efficiency, is entitled to rank as third, the United States navy taking the second position.

With one important exception, the German navy, in respect of its physical characteristics, or *materiel*, is thoroughly up-to-date, both in design and workmanship. That is to say, the ships of each period were well abreast of naval development at the time they were designed. The one exception, which relates to the armament, seriously affects the efficiency of all battleships completed previous to 1903, and in a less degree those completed between 1903 and 1908. We refer to the comparative weakness of the main armament; for in none of the German battleships afloat to-day is there a gun mounted that is heavier than the 11-inch, 40-caliber piece, which constitutes the main armament of the ten latest ships of the "Deutschland" and "Braunschweig" types. The earlier battleships, of the "Wittelsbach" and "Kaiser Friedrich" classes, ten ships in all, carry only a 40-caliber, 9.4-inch gun in the main armament. The 40-caliber, 11-inch fires a shell of 595 pounds weight, which is capable of penetrating 6 inches of modern armor at 8,000 yards (the probable battle range of the future). The 9.4-inch, 40-caliber gun fires a shell of 309 pounds weight, which can penetrate only 4½ inches of armor at 8,000 yards. The lack of power in these guns will be evident if they are compared with our 12-inch gun, firing an 850-pound shell, which is good for 11 inches of armor at 8,000 yards range.

The weakness of the main armament did not attract much attention until the advent of the "Dreadnought" type of warship, armed exclusively with 12-inch guns of great range and penetrating power; and the German nation is entitled to great credit for the characteristic energy with which they have recognized the defect, and set about what is practically the creation of a new navy. "Dreadnoughts" of great size and power were at once laid down, and the work upon them pushed with such energy that two of them, the "Nassau" and "Westfalen," are afloat; two more are on the eve of launching; three others will be laid down this year, and another three next year; and all will be completed in the spring of 1912. Furthermore, the Germans are building three "Dreadnought" cruisers. One of these is launched, another is about to be, and a third, to be laid down this autumn, will be completed in the same year, so that early in 1912 Germany will possess thirteen ships all mounting heavy long-range, armor-piercing guns exclusively. The new gun, by the way, although it is an 11-inch piece as compared with the 12-inch carried by the "Dreadnoughts" of other navies, will have the great length of 50 calibers, and will deliver its 760-pound shell with a velocity of 3,250 feet a second, and will be capable of piercing 9 inches of Krupp steel at 8,000 yards. This is a slightly more powerful gun than our 40-caliber, 12-inch, which is good for 8¾ inches at that range; but it is not equal to our 45-caliber, 12-inch, whose penetration for that distance is, as stated above, 11 inches.

SUMMARY.—In the present series of naval articles, we are following a method of classification which includes under the head of first-class battleships all those which are less than twenty years old and of 10,000 tons displacement or over. It may seem somewhat absurd to include in the same class as the modern "Dreadnought" a vessel twenty years older. But since it is impossible to find a system of classification which will satisfy everybody, perhaps the best method is to arrange the ships on this plan, and leave each individual to make his own subdivision to please himself. On the twenty-year-old, 10,000-ton basis, then, we find that Germany possesses twenty-eight battleships, either built or nearing completion, of a total displacement of 355,738 tons; and of older battleships now relegated to coast defense, it possesses eight of 33,200 tons. Of first-class cruisers, ranging in displacement from 8,760 tons to 19,000 tons and of from 19 to 25 knots speed, she has built, or now has under construction, eleven ships of an aggregate displacement of 131,000 tons. All of these vessels are of the armored cruiser type, with a continuous belt from stem to stern. Of second-class cruisers, Germany possesses six vessels of a little under 6,000 tons displacement and 19½ to 21 knots speed, aggregating 34,245 tons. These are of the protected cruiser type, with no waterline armor, but a complete protective deck of considerable thickness. Of the third class of the protected type, Germany possesses a large number of ships, most of them of 21 to 25 knots speed. The displacement varies from 2,600 tons to 3,740 tons, which is the displacement of the pair of 25-knot scout cruisers recently laid down. The aggregate displacement of these ships is 88,947 tons. The torpedo-boat destroyer fleet includes ninety-three vessels, of from 280 to 670 tons displacement, and from 21 to 30 knots speed. As yet, Germany has given but little attention to submarines, and she possesses but four boats, built or under construction, concerning which but little information is obtainable.

BATTLESHIPS.—The German navy is essentially modern; that is to say, it includes fewer obsolete ships in its list of effectives than any other navy, unless indeed the light armament be considered to render them so. It was not until early in the nineties that the government built its first group of battleships of the modern type; that is to say, ships embodying a sufficient number of the elements that go to make up a first-class modern battleship to enable them to remain on the active list at the present day. Early in 1890, five ships of the "Brandenburg" class were laid down. They are of about the same displacement (10,060 tons) as our own "Oregon" class. They were designed for a speed of 17 knots, which they attained on trial, although the speed is, of course, somewhat lower to-day. They carry a complete waterline belt of compound armor, 12 inches thick at the ends, and 15 inches amidship. They were remarkable in their day for the fact that they carried two more heavy guns in their main battery than the contemporary battleships of other navies, the main armament consisting of four 40-caliber, 11-inch guns and two 35-caliber, 11-inch, carried in three turrets on the axis of the ship; two forward on the forecastle deck, two amidships, and two astern on the main deck. The secondary battery was light, consisting of eight 4.1-inch guns, so that in respect of armament the "Brandenburgs" were an anticipation of the modern "Dreadnought." The barbettes were protected by 12 inches, and the turrets by 5 inches of compound armor. The effectiveness of the main battery is limited, as in the case of most other battleships of that period, by the fact that the turrets had to be swung around to the end-on position, between every round, before loading. The freeboard, also, as in the case of our own "Oregon" class, is low, except forward, where the 11-inch guns are carried upon a forecastle deck, which should give these ships an advantage over the "Oregon" in steaming to windward.

Following the "Brandenburg" class came the five ships of the "Kaiser" class, which includes the "Kaiser Friedrich III.," "Kaiser Wilhelm II.," "Kaiser Wilhelm der Grosse," and "Kaiser Karl der Grosse." These vessels marked a decided advance in everything, except the main armament, over the "Brandenburg" class. They are of about 1,000 tons greater displacement and 30 feet longer on the waterline, while the speed realized on trial was, in every case, 18 knots or over. They carry 1,050 tons of coal, and also 100 tons of liquid fuel, the latter in the double bottom. For some reason which has never been stated, the German government decided that the 9.4-inch Krupp gun was a sufficiently powerful piece to mount on modern battleships; and this was chosen for the vessels of this class. But if the main armament was light, the secondary armament of eighteen 6-inch guns was unusually powerful for a vessel of this displacement. The secondary battery is, moreover, exceedingly well mounted, six of the pieces being carried on the upper deck in six single turrets protected by 6-inch armor, the other twelve being mounted in casemates, eight on the upper and four on the main deck. The protection of these ships was in advance of that of contemporary battleships, consisting entirely of the then new Krupp armor. It includes a 12-inch belt, a 3-inch deck, 10-inch protection for turrets and barbettes, and 6-inch protection for the secondary battery. In this class of ship the government introduced, for the first time, triple-screw propulsion, a system which has been maintained in all the later battleships. The "Kaiser Barbarossa," of 10,790 tons displacement, 17.5 knots speed, launched in 1900 and reconstructed in 1907, should, strictly speaking, be reckoned in the "Kaiser" class, from which she differs chiefly in the removal of four 6-inch guns from the main deck, and in the removal of top weights in the way of bridges, superstructures, and military masts.

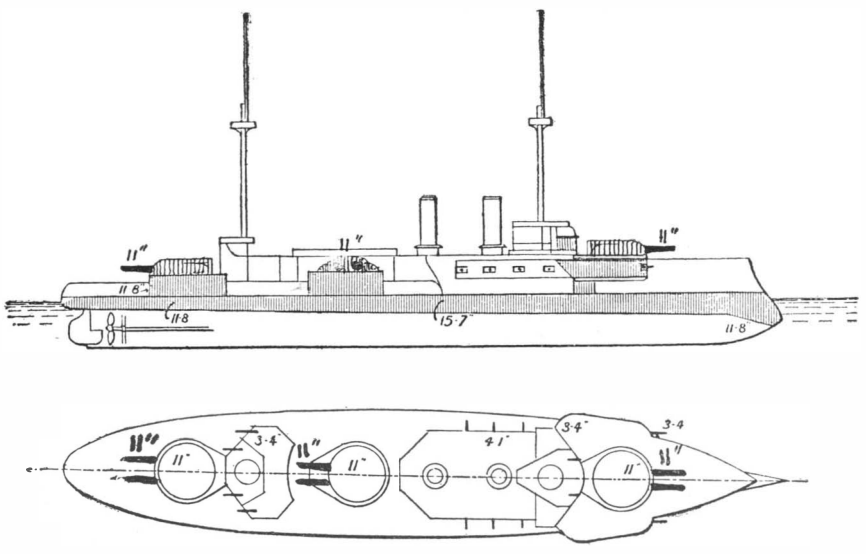
The "Wittelsbach" class of five ships shows the gradual increase in displacement, which reaches 11,830 tons in these ships. The speed is 18 knots, and the coal supply was increased to 1,400 tons, with 200 tons of liquid fuel carried in the double bottom. The freeboard was improved by maintaining the upper deck flush throughout the whole length of the ship. The main battery consists of four 9.4-inch guns; the forward pair carried at the forward end of the superstructure deck with a lofty command of 30 feet above the water. The after pair is mounted on the upper deck with a command of about 25 feet. An important change, as compared with the "Kaiser" class, was made in the mounting of the secondary battery of eighteen 6-inch guns. Fourteen of these are emplaced behind 5¼-inch armor, in a central two-deck battery, ten guns on the main deck, and four on the upper deck in casemates. The other four guns are mounted forward in casemates, two abreast and two ahead of the forward 9.4-inch guns. Great at-

tention has been paid to securing heavy end-on fire, which ahead consists of two 9.4 and eight 6-inch guns, while the astern fire is two 9.4 and six 6-inch. In the "Wittelsbach" class, the thickness of the belt as compared with the "Kaiser Friedrich III." was reduced from 12 inches to 9 inches. With this is associated a deck 3 inches thick on the slope; while from main turret to main turret the side of the ship is protected from the belt to the gun deck by 5½ inches of armor. The barbettes and turrets have 10 inches protection, and the casemates of the secondary battery 6 inches.

In 1901-2 the Germans laid down another class of five ships known as the "Braunschweig" class. As compared with their predecessors, their displacement was increased from 11,830 to 13,200 tons, and the coal supply from 1,400 to 1,600 tons, with 200 tons of liquid fuel. The designed speed was the same, or 18 knots, with 16,000 horse-power. The system of armor protection is practically the same, except that the side armor was carried, unbroken, from main barbette to main barbette up to the main deck, and the barbette and turret armor was increased to 11 inches. The main armament is more powerful, and a considerable increase was made in the power of the secondary battery, the 6-inch gun being replaced by a more powerful piece of 6.7 inches caliber, which is capable of penetrating 5¾ inches of Krupp steel at 5,000 yards, as against a penetration by the 6-inch guns at the same range of 3½ inches. It should be mentioned here that the "Braunschweig" class, like the two that preceded it, carries an unusually powerful torpedo armament, consisting of six torpedo tubes, 17.7 inches in diameter; five of them submerged, and one at the stern above water, the stern torpedo being protected by armor. Four of the submerged tubes are mounted in broadsides, and the fifth is built into the bow of the ship, just below the ram, an arrangement not found in ships of any other power. In the "Braunschweig" class the Germans remedied the unquestionable weakness of the main battery in their earlier ships, by mounting four 40-caliber, 11-inch guns. Although this piece is weak in comparison with our 45-caliber, 12-inch piece as mounted in the "Connecticut" and "Kansas" classes, its penetration being but 6 inches at 8,000 yards, as compared with 11 inches of our 12-inch piece, it marked a considerable advance over the 9.4-inch of preceding battleships, whose penetration at 8,000 yards is only 4½ inches. The secondary battery was greatly strengthened by substituting a new 6.7-inch, 40-caliber gun for the 6-inch used in previous ships. Ten of the fourteen 6.7-inch guns are mounted in a central battery on the gun deck, and four in turrets on the deck above.

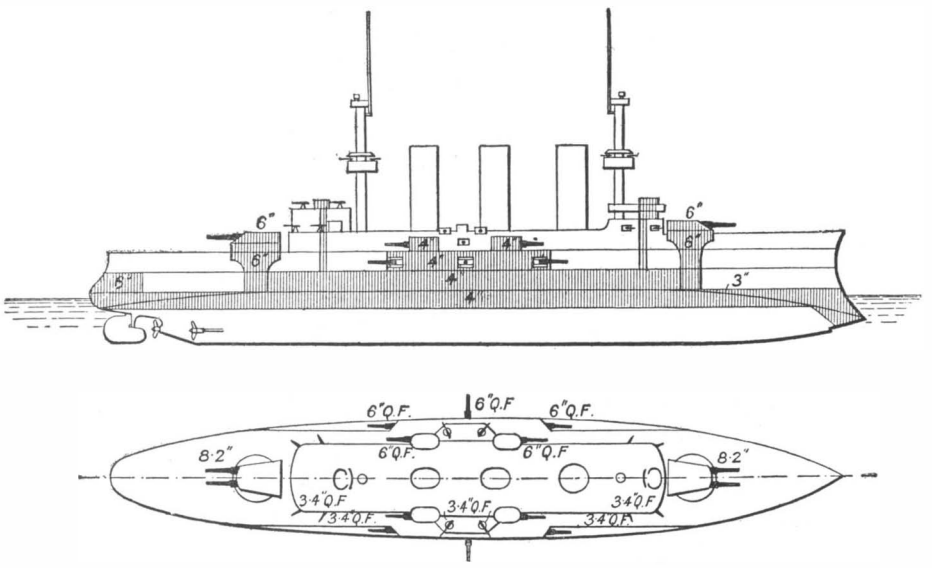
In 1903-5 the battleship fleet was increased by the laying down of five ships of the "Deutschland" class. These vessels differ from the "Braunschweig" only in the armor protection, which is increased. It consists of 9¾ inches at the waterline, 11 inches on the barbettes and turrets, and 6¼ and 6¾ inches on the batteries and casemates; while the side protection was improved by increasing the thickness of armor on the lower deck from 5 inches to 8 inches. The armament consists of four 11-inch and fourteen 6.7-inch guns, the secondary battery being mounted as in the "Braunschweig," with the difference that the four guns on the main deck are emplaced in casemates instead of in turrets. The coal supply was increased to 1,800 tons, and the speed remains at 18.5 knots.

But if Germany had fallen behind the other powers in respect of the size and gun power of her battleships, when once she had adopted a policy of building all-big-gun, high-speed "Dreadnoughts," she put it into execution with characteristic German thoroughness. In July and August, 1907, she laid down four "Dreadnoughts" of about 18,000 tons displacement and 19 knots speed. Much doubt has existed as to the armament of these ships, and it has been variously given as including ten to sixteen 11-inch guns. As a matter of fact, they will carry twelve such pieces, all of the new and powerful 50-caliber pattern. The hulls of the ships will follow the general "Dreadnought" lines, the general freeboard being about 18 to 20



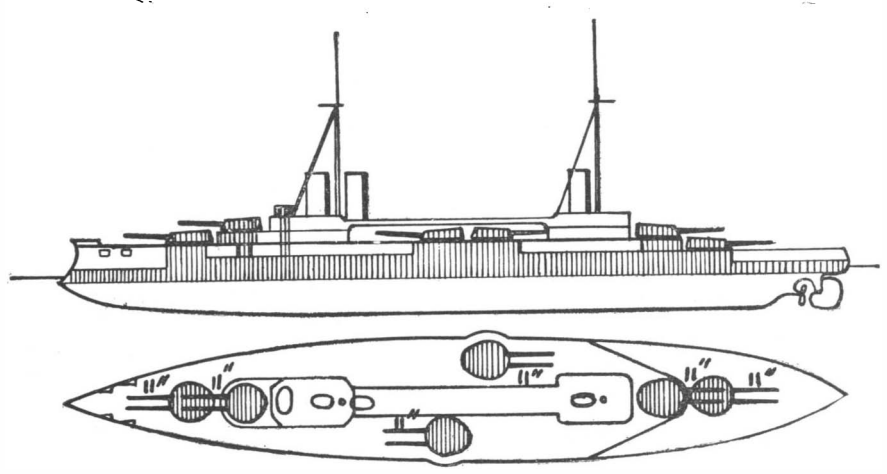
Displacement, 10,000 tons. **Speed,** 17. **Coal,** 1,050 tons. **Armor:** Belt, 15-inch compound; barbettes, 12 inches. **Armament:** Six 11-inch; eight 4.1-inch guns.

Battleship "Brandenburg." Class of Four Ships.



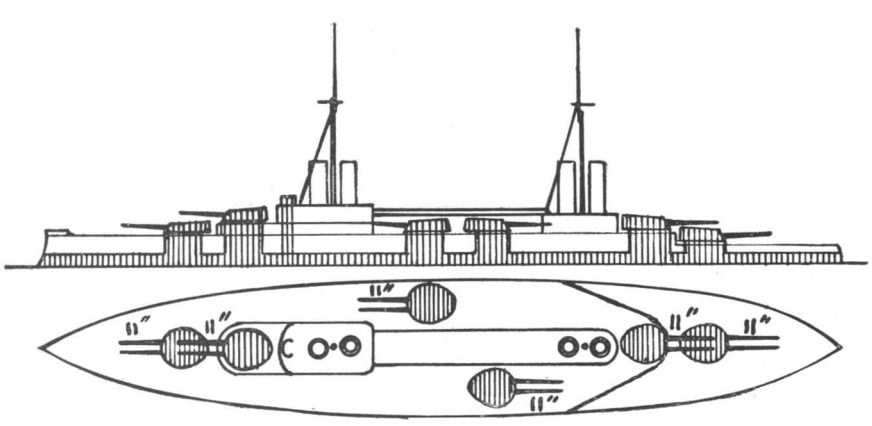
Displacement, 9,050 tons. **Speed,** 21. **Armament:** Four 8.2-inch; ten 6-inch guns. **Armor:** Belt, 4 inches; deck, 3 inches; gun positions, 4 inches.

Armored Cruiser "Prinz Friedrich Karl." Class of Three Ships.



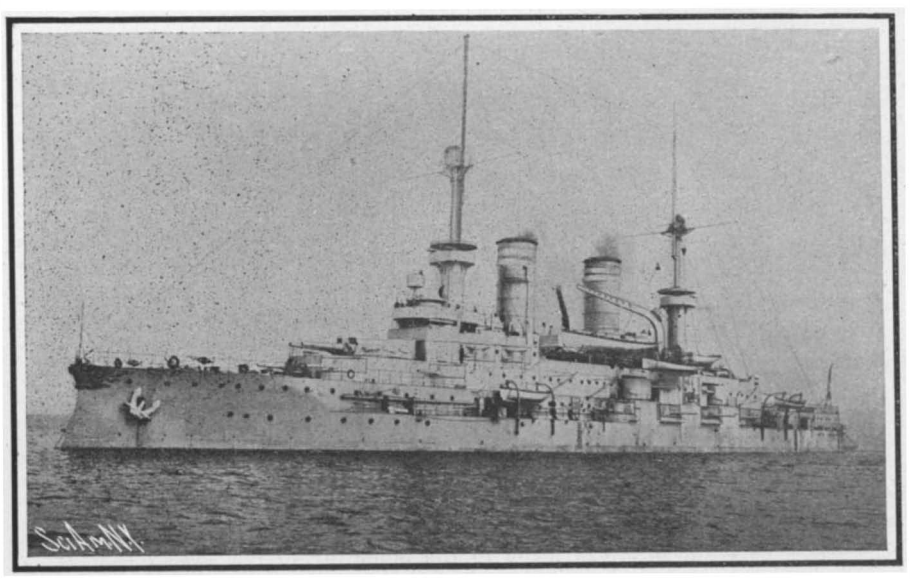
This is the German answer to the "Dreadnought."
Displacement, 18,000 tons. **Armament:** Twelve 11-inch 50-caliber guns. **Speed,** 19.

"Nassau." Class of Seven Ships of Dreadnought Type.



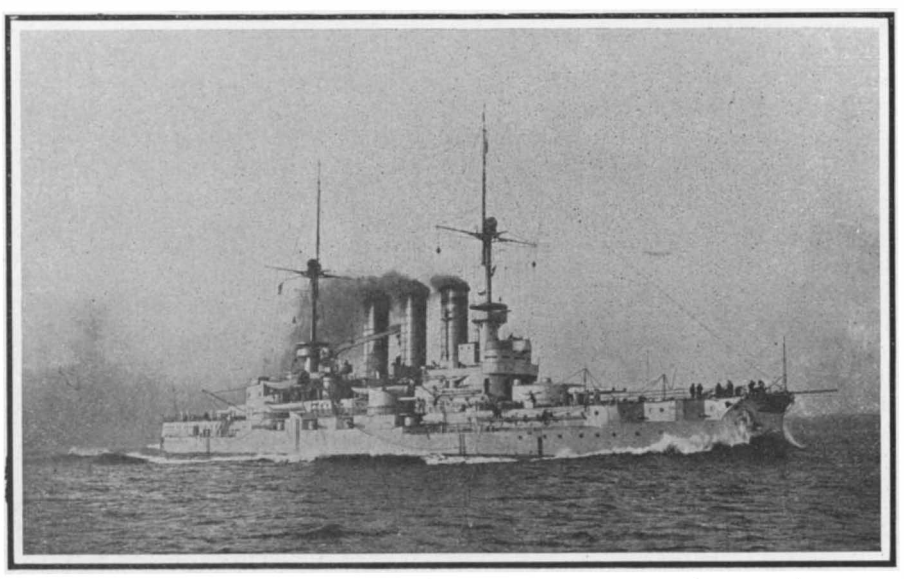
German answer to the "Indomitable."
Displacement, 19,000 tons. **Speed,** 25. **Armament:** Twelve 11-inch guns.

"F." Class of Two Ships of Cruiser-Battleship Type.



Displacement, 11,643 tons. **Speed,** 18. **Coal,** 1,450 tons, and oil. **Armor:** Belt, 9 inches to 4 inches; deck, 3 inches; side, 5½ inches; gun positions, 10 inches to 6 inches. **Armament:** Four 9.4-inch and eighteen 6-inch guns. **Torpedo tubes,** six (five submerged). **Complement,** 715. **Date,** 1902.

Battleship "Wettin." Class of Five Ships.



Displacement, 12,997 tons. **Speed,** 18.0. **Coal,** 1,600 tons, and oil. **Armor:** Belt, 9 inches to 4 inches; deck, 3 inches; side, 6 inches; gun positions, 10 inches to 6 inches. **Armament:** Four 11-inch; fourteen 6.7-inch; twelve 3.4-inch; twenty small guns. **Torpedo tubes,** six submerged. **Complement,** 660. **Date,** 1904.

Battleship "Braunschweig." Class of Five Ships.

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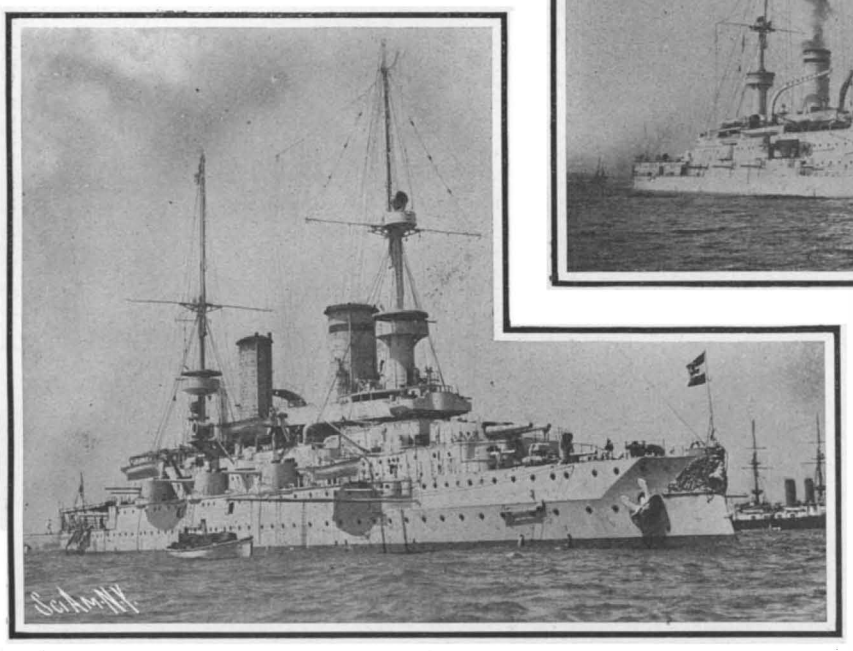
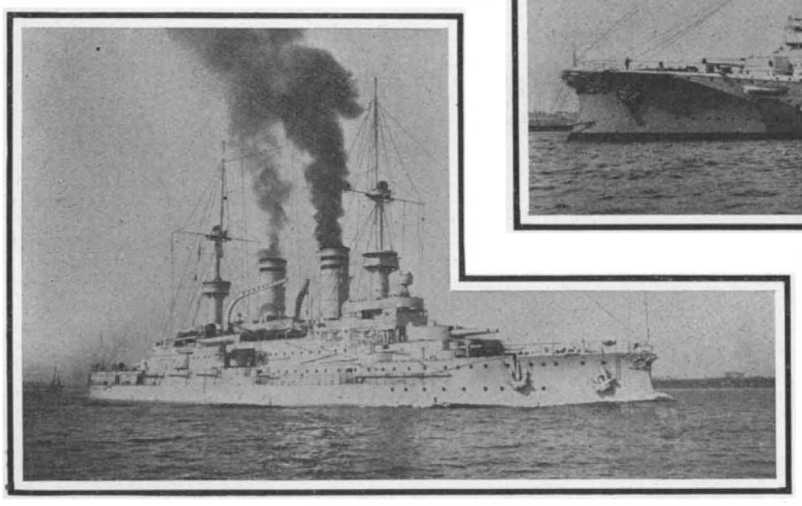
feet, with a forecastle deck of 28 feet freeboard. Forward and aft will be a pair of two-gun turrets mounted, as in our own "South Carolina" and "Michigan," the guns of one pair firing above the roof of the adjoining turrets, and the two other turrets will be placed diagonally athwartships. The concentration of fire by this arrangement will be very powerful, consisting of eight 11-inch dead ahead and dead astern, and twelve 11-inch on either broadside. Compared with our own "Dreadnoughts," the "Nassau" class is inferior in speed, but possibly superior in gun power. The 50-caliber, 11-inch gun delivers its 760-pound shell at the enormous velocity of 3,250 feet per second, and it is capable of penetrating 18½ inches of Krupp armor at 5,000 yards, and 9 inches at 8,000 yards, as against 16½ inches and 11 inches, respectively, of penetration for our 45-caliber, 12-inch piece. In addition to the four "Dreadnoughts" laid down last year, the Germans are commencing three this year, and three more will be laid down in 1909. For the present, however, they have seven ships of the "Dreadnought" class in hand.



Displacement, 10,914 tons. **Speed,** 18.0. **Coal Supply,** 1,050 tons, and oil. **Armor:** Belt, 11¾ inches; deck, 3 inches; gun positions, 9¾ inchesand 6 inches. **Armament:** Four 9.4 inch; eighteen 5.9 inch; twelve 3.3 inch; twenty small guns. **Torpedo tubes,** six (five submerged). **Complement,** 700. **Date,** 1898.

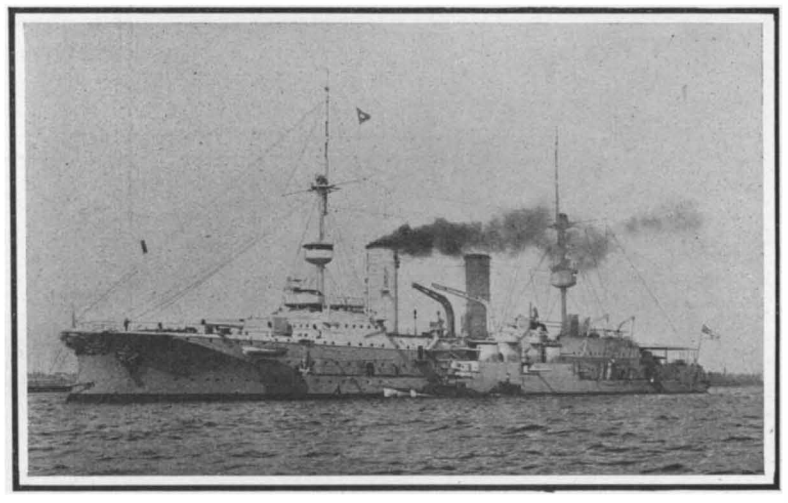
Battleship "Kaiser Friedrich III." Class of Five Ships.

ARMORED CRUISERS.—The strength of the German navy lies in the number and homogeneity of its battleships, and relatively little of the total displacement of the navy has been put into armored cruisers, of which, at present, the navy has but eight, with three of the all-big-gun type under construction. The earliest of this class is the "Fuerst Bismarck," of 10,700 tons and 19 knots, and 1,200 tons coal capacity. She has an 8-inch belt and 4-inch deck, and mounts four 9.4-inch guns in barbette turrets, protected by 8 inches of Krupp armor. The secondary battery consists of twelve 6-inch, mounted either in casemates or turrets, four on the gun deck, six on the main deck, and two on the forecastle deck. She has a high freeboard, good gun command, and was an excellent ship of her day. Following the "Fuerst Bismarck" came the "Prinz Heinrich" of 8,930 tons and 20 knots. She has a 4-inch belt, 6-inch protection to the turrets, and 4 inches on the central battery and casemates. She is armed with two 9.4-inch and ten 6-inch 40-caliber guns, and can stow 1,500 tons of coal and 200 tons of liquid fuel. From 1901 to 1904, there were launched four armored cruisers of the "Prinz Adelbert" and "Roon" classes, mounting four 8.2-inch guns in turrets behind 6 inches of armor and ten 6-inch guns in a central battery protected by 4 inches of armor. She has a 4-inch continuous belt, associated with a 2-inch deck. The weakest feature of these last five ships is the light protection of only 4 inches at the waterline. In the next pair of cruisers of the "Scharnhorst" class, of 11,600 tons and 22½ knots speed, the increased dimensions permitted of a considerable all-around improvement in the protection. The belt is from 6 inches to 4¾ inches in thickness; the barbettes and turret hoods are protected by 6 and 6¾ inches, and the lower deck side and the upper battery by 6¾ inches of Krupp steel. Two thousand tons of coal can be stored in the bunkers, and 200 tons of oil in the double bottom.



Displacement, 11,643 tons. **Speed,** 18.1. **Coal Supply,** 1,450 tons, and oil. **Armor:** Belt, 9 inches to 4 inches; deck, 3 inches; side armor, 5½ inches; gun positions, 10 inches and 6 inches. **Armament:** Four 9.4 inch; eighteen 5.9 inch; twelve 3.3 inch; twelve 1.4 inch; eight machine guns. **Torpedo tubes,** six (five submerged). **Complement,** 715. **Date,** 1903.

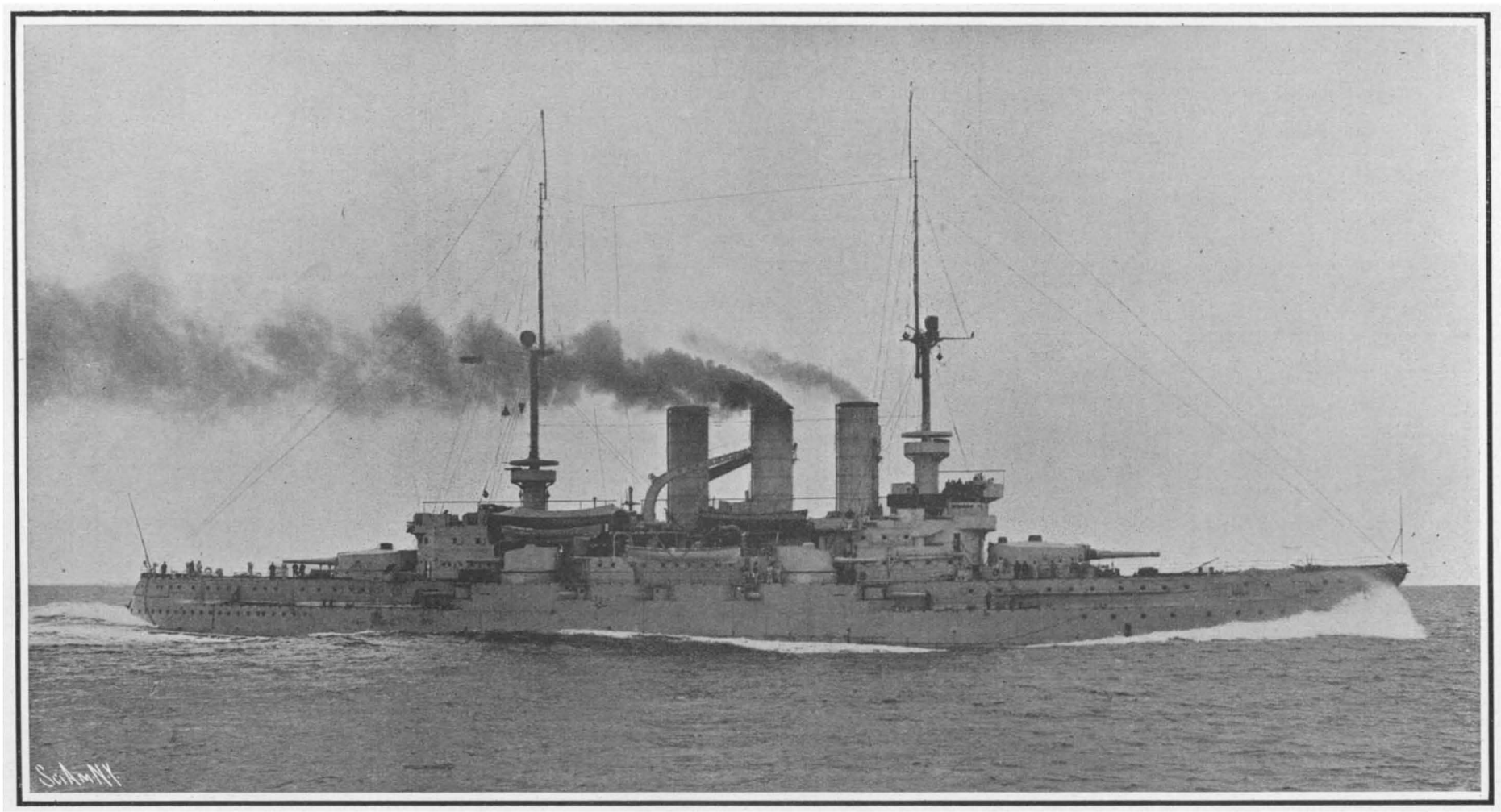
Battleship "Mecklenburg." ("Wettin" Class.)



Displacement, 8,930 tons. **Speed,** 20.3. **Coal,** 1,500 tons, and oil. **Armor:** Belt, 4 inches; deck, 2½ inches; side, 4 inches; gun positions, 6 inches to 4 inches. **Armament:** Two 9.4 inch; ten 6 inch; ten 3.4 inch; fourteen small guns. **Torpedo tubes,** four (three submerged). **Complement,** 528. **Date,** 1902.

Armored Cruiser "Prinz Heinrich."

As an answer to the British armored cruisers of the "Indomitable" class, the Germans have three all-big-gun cruisers under construction. One, the "Bluecher," of 14,760 tons displacement and 22½ knots speed, has been launched. She will carry eight 11-inch, 50-caliber guns, mounted in four turrets, one forward, one aft, and one on each broadside. Two other cruisers of this type are under construction, each of which will displace 19,000 tons, and carry a battery of twelve 11-inch guns mounted similarly to



Displacement, 12,997 tons. **Speed,** 18.6. **Coal,** 1,600 tons, and oil. **Armor:** Belt, 9 inches to 4 inches; deck, 3 inches; side, 6 inches; gun positions, 10 inches to 6 inches. **Armament:** Four 11-inch; fourteen 6.7-inch; twelve 3.4-inch; twenty small guns. **Torpedo tubes,** six (five submerged). **Complement,** 660. **Date,** 1905.

Battleship "Preussen." ("Braunschweig" Class.)

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those of the main battery of the battleship "Nassau." These two ships are designed to steam at 25 knots, and they will probably be driven by turbine engines.

PROTECTED CRUISERS.—The protected cruiser, except in its latest development as a fast, lightly-armored scout, may be said to have had its day. Too slow for scouting, and too lightly protected to be able to encounter the armored cruisers of the enemy, it is difficult to say just what its field of operations will be in the next naval war. Germany possesses thirty-four ships of this class, ranging in displacement from 2,603 up to 5,956 tons, and in speed from 19 to 25 knots. The larger ships of the "Freya" class carry two 8.2-inch and eight 6-inch guns. The smaller cruisers are armed chiefly with the 4.1 inch. The latest vessels range from 3,200 to 3,740 tons in displacement, and the speed has been gradually increased from 23 to 25 knots, the last four ships of this class to be built, the 24½-knot "Ersatz-Pfeil" and "Dresden," and the "Ersatz-Greil" and "Ersatz-Yajd," of 25 knots speed, being cruisers of the scout class, corresponding to our own "Salem," "Chester," and "Birmingham."

DESTROYERS.—The fleet of torpedo-boat destroyers calls for no special mention. The speeds are moderate, the Germans never having attempted to go above 30 knots except in the case of one vessel known as "G 137," a 572-ton boat which made about 34 knots an hour. The earlier boats, built in the late eighties and early nineties, were of 21 to 23 knots speed. In 1900 the speed had been raised to 27 and 28 knots; and in 1905 it reached 28½ knots. The boats authorized in 1906, 1907, 1908, a dozen in each year, are to show 30 knots an hour. The German navy is only now entering seriously upon the construction of submarines; the one completed ship of which any details are known, is about 130 feet in length, displaces 190 tons, and is credited with a speed of 12 knots on the surface and 9 submerged. The particulars of the later boats are not available.

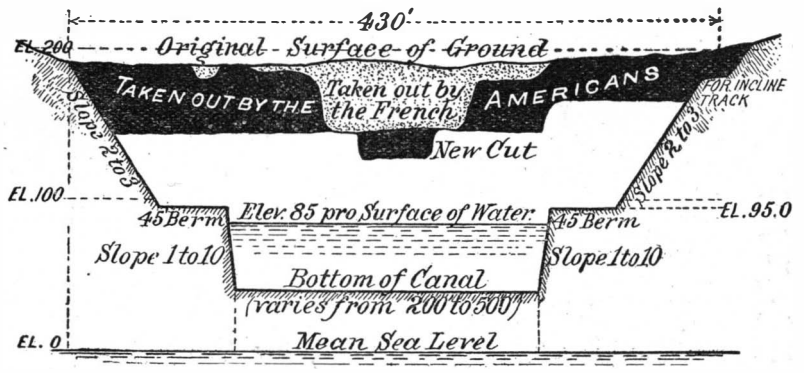
PROGRESS OF EXCAVATION OF CULEBRA CUT.

In recent issues of the SCIENTIFIC AMERICAN we have kept our readers informed of the rapid rate of excavation which has been attained in cutting the Panama Canal through the low range of mountains which forms the divide through the Isthmus. A mere statement of total quantities, however, unless one is used to thinking in engineering figures, may fail to give an adequate representation to the mind of what is being done. We publish, therefore, the accompanying typical cross section of the Culebra cut, in which the relative amount of material taken out by the French and by the United States government is shown, together with the total amount which must be removed to complete the canal to its full depth. It will be seen that the width of the cut at the original surface of the ground is about 450 feet, and that the highest point of the cut is 200 feet above mean sea level. For the first 105 feet of depth the sides of the cut have a slope of 2 to 3. At an elevation of 95 feet above sea level there is on each side of the canal a berm, or roadway, 45 feet in width, for the accommodation of railroad tracks or roads for vehicles. This brings us to the top of the canal prism proper, the walls of which have a slope of 1 to 10 to the bottom of the canal, which is 45 feet deep and in the section here shown has a bottom width of 200 feet. In other parts of the canal, outside the Culebra cut, the width will be increased according to conditions, up to 500 feet.

The amount of material taken out of the cut during the French administration is shown by stippled shading. During the old French *régime* of from 1881 to 1899, 12,600,000 cubic yards were removed; under the new French *régime* of 1895 to May, 1904, 10,000,000 cubic yards were removed. The total amount taken out by the French, therefore, was 22,600,000 cubic yards.

The excavation done by the United States government is shown in full black. With the advent of the Americans came the magnificent excavating machinery, which had been developed during the past two decades for the excavation of large American works, such as the Chicago drainage canal and the heavier work on our main steam railroads. By the lavish use of this machinery it has been possible to remove in a given time an amount of yardage which could never have been taken out with the lighter machinery used from fifteen to twenty years ago. As soon as the machinery was installed and set to work, the rate of progress increased very rapidly. The amount of material removed under American administration up to June 1 of the present year was 18,445,426 cubic yards, and over 11,000,000 cubic yards of this was taken out during the last twelve months, representing an average of 932,624 cubic yards per month. On June 1, 1908, there remained to be excavated, in order to complete the Culebra cut, 39,652,822 cubic yards. These figures show that the great cut through the divide is about one-half completed.

So rapid is the rate of progress at Culebra, that its excavation is no longer considered to be the controlling factor as to time of the completion of the canal. In all probability, the last shovelful of material will have been removed before another three years has elapsed, and many months, if not a year or two, before the huge triple flight of locks at Gatun has been completed.



Cross Section of the Culebra Cut, Showing Progress of Excavation June 1, 1908.

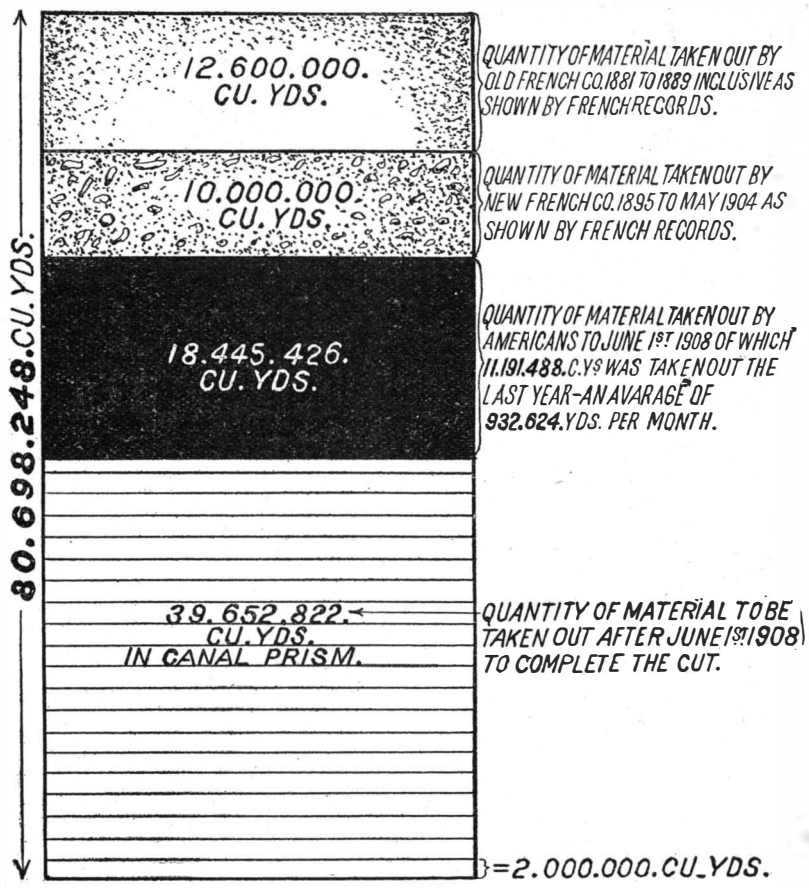

80.698.248.CU.YDS.
12.600.000. CU. YDS.
QUANTITY OF MATERIAL TAKEN OUT BY OLD FRENCH CO. 1881 TO 1889 INCLUSIVE AS SHOWN BY FRENCH RECORDS.
10.000.000. CU. YDS.
QUANTITY OF MATERIAL TAKEN OUT BY NEW FRENCH CO. 1895 TO MAY 1904 AS SHOWN BY FRENCH RECORDS.
18.445.426. CU. YDS.
QUANTITY OF MATERIAL TAKEN OUT BY AMERICANS TO JUNE 1ST 1908 OF WHICH 11.191.488. C.YDS WAS TAKEN OUT THE LAST YEAR—AN AVARAGE OF 932.624. YDS. PER MONTH.
39.652.822. CU. YDS. IN CANAL PRISM.
QUANTITY OF MATERIAL TO BE TAKEN OUT AFTER JUNE 1ST 1908 TO COMPLETE THE CUT.
=2.000.000.CU.YDS.

Diagram Showing Work Done at Culebra Cut by the French and the United States Engineers.

Producer Gas for Steam Generation.

The use of producer gas in place of solid fuel for steam generation has as yet made little headway, although there is much to be said in its favor from the point of view of convenience and cleanliness. A paper by J. H. Lester, M.Sc., published in the issue of the Journal Soc. Chem. Industry for May 15, describes a remarkable experimental form of gas-heated steam boiler which, if it can be copied on a large scale, will be likely to revolutionize the present methods of steam generation.

As an example of the high duty obtainable in steam production with this form of boiler, Mr. Lester states that a series of his gas-heated tubes built up into a block occupying only one cubic yard of space, would evaporate as much water as a Lancashire boiler measuring 30 feet by 8 feet diameter and that the efficiency of the new boiler would be as high as that of the Lancashire boiler when worked with economizers.

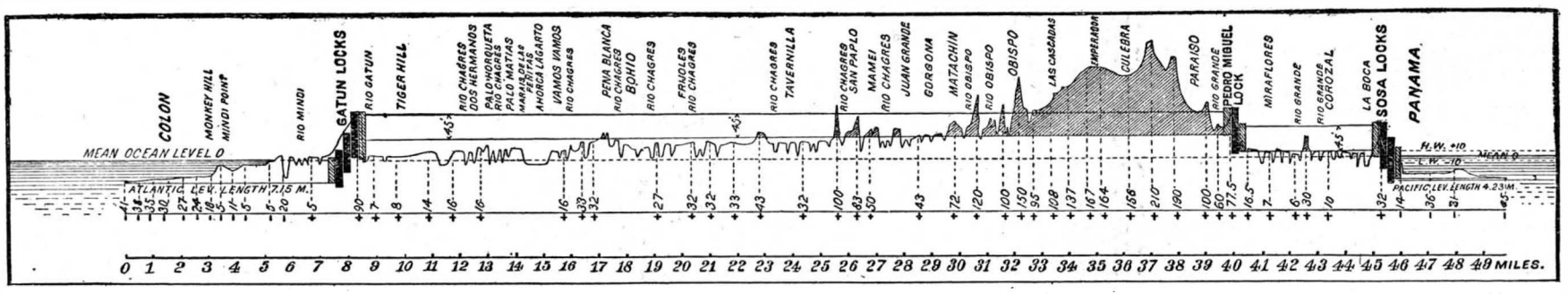
The experimental boiler designed by Mr. Lester consisted simply of a copper tube of 3/16 inch internal diameter, and 20 inches in length, surrounded by a jacket allowing 1/16 inch space between the two tubes.

The gas and air mixture entered at the top of the inner tube, and by careful regulation a flame 7 inches in length, showing less than 0.50 per cent of free oxygen, and less than 0.50 per cent of carbon monoxide in the exit gases, could be obtained. The water entered the annular space between the two tubes, and flowed upward, in the opposite direction to that of the gas mixture. The cooling of the gas by the adoption of this principle of counter-current circulation was so effective, that the latent heat of condensation of the water produced by the combustion of the gas was recovered; and the total loss of heat at the base (or chimney end) of the combustion tube never exceeded five per cent. Mr. Lester, in fact, believes that by lengthening his tubes he could recover 100 per cent of the calorific value of the gas in the water, and thus convert his boiler into a calorimeter.

The steam passed away by an outlet in the side of the upper part of the outer tube. The restricted space available for water was purposely adopted, in order to prevent any downward current of water in the annular space.

The burning of the gas with the minimum of oxygen supply, of course increased the final temperature attained by the gas mixture, and therefore the efficiency of the boiler. It was found experimentally, that the production of a rapid series of gas explosions, or musical notes, appeared to be coincident with the conditions required for this perfect combustion; and that the mixture giving the highest musical note when ignited, gave the most satisfactory results as regarded low percentages of free oxygen and carbon monoxide in the exit gases.

A boiler constructed upon this principle, using producer gas, might therefore convert 95 per cent of the heating value of the gas into the thermal energy of steam; and as Mr. Lester remarks, the construction of such a boiler does not offer insuperable difficulties.



The canal extends from the 40-foot line on the Atlantic to the 40-foot line on the Pacific, a distance of 50 miles. The first 8 miles is a sea-level channel; next is 24 miles of lake navigation at 85 feet above sea level; then 7½ miles of narrow canal through the Culebra hills; then 5 miles of lake navigation at 55-foot level; and, last, 4½ miles at sea level.

PROFILE OF THE PANAMA CANAL.

The tallest chimney in the world is now under construction at the Great Falls, Mont., smelter of the Amalgamated Copper Company. It has a foundation 74 ft. in diameter and 506 ft. high, with a 54-foot diameter top. Connections with the furnaces will be made by a flue 20 ft. high. 48 ft. wide, and 1,800 ft. long. The tallest chimney hitherto built is that of the Halsbrucker Hütte, near Freiberg, Germany, 460 ft. in height.

THE OPACITY OF BONES TO ROENTGEN RAYS AS AN INDICATION OF AGE.

BY JACQUES BOYER.

According to the law of Flourens, the duration of the period of growth bears a definite relation to longevity and, in particular, the time occupied by any animal in attaining its maximum stature is a definite fraction, constant for all the individuals of the species, of the duration of the animal's life. Now, the maximum stature is attained simultaneously with the maximum development of the skeleton and, as the weight of the skeleton is a function of the amount of mineral salts which it contains, the law may be expressed in a more mathematical form by saying that the percentage of mineral salts in the bones of all animals of the same species may be represented by similar curves of growth and decline, which will differ solely in the values of individual constants.

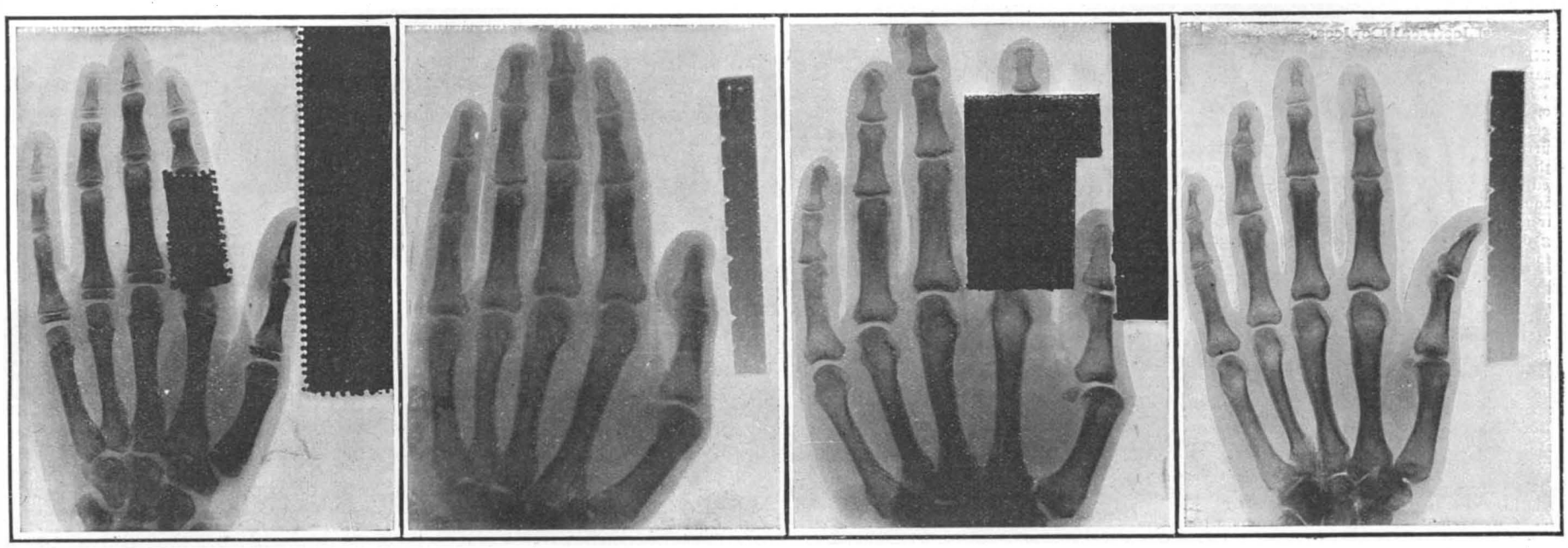
Prof. Charles Henry, taking advantage of the possibility of determining, indirectly, the mineral content of bones in the living subject, by means of their opacity to Roentgen rays, has been examining the hands of a large number of human subjects of various ages in order to verify the law of Flourens.

Henry used a Roentgen tube with a double anode, a Carpentier coil and Lumière Sigma photographic plates. In order to eliminate the influence of variations in the tube and the coil, simultaneous radiographs were made of the hand and of a strip of aluminium foil of varying thickness, which served as a standard. After the plates had been developed, the films were stripped from the glass and the degree of transparency of certain parts was measured with a D'Arsonval diaphragm photometer. As the films are negatives, the transparency of the film is evidently proportional to the opacity of the bone. The portions of the film selected for photometric measurement were the image of the aluminium foil and, usually, that of the third joint of the middle finger. Finally, one of the films was taken as a standard, the aluminium strip of that film being compared in the photometer with the aluminium strip of each of the other films. The source of light for the photometer measurements was an Auer burner, the light of which was diffused by a ground glass screen. The opacities of the bones were expressed in thickness of aluminium.

From his examinations of subjects of various ages Prof. Henry has deduced a maximum opacity at from 30 to 32 years (the age at which the height and weight normally reach their maxima), and a minimum opacity at 45 years. Tribob has supplemented these radiographic results by analyzing the ash of bones of deceased persons of various ages and both sexes, with special reference to the percentage of calcium phosphate. The results of the chemical analysis confirm those of the radiographic examination, but appear to indicate a second minimum of opacity at 65 years of age.

The measurements that have already been completed are too few to warrant the drawing of more definite conclusions. A great many determinations will be required in order to establish the mean curve, and find the positive or negative deviation corresponding to any given age. After all this has been done it will be possible to draw conclusions with respect to mean longevity and to calculate the "expectation of life" of a person of given age and measured opacity. It will then be possible, also, to calculate the personal coefficient of correction and from this to establish life insurance premiums on a more equitable basis than is furnished by tables of mortality. But it would be a waste, perhaps, to ask insurance companies to change a system which they have found so profitable, or to endeavor to induce the insured to submit to an examination which would result in condemnation to death at a more or less distant date.

Physicians, however, will derive useful information from Prof. Henry's radiographic studies, for the determination of the percentage of mineral salts in the bones of a patient should facilitate both diagnosis and treatment.



Child aged 15. Man aged 20. Woman aged 45. Woman aged 75.

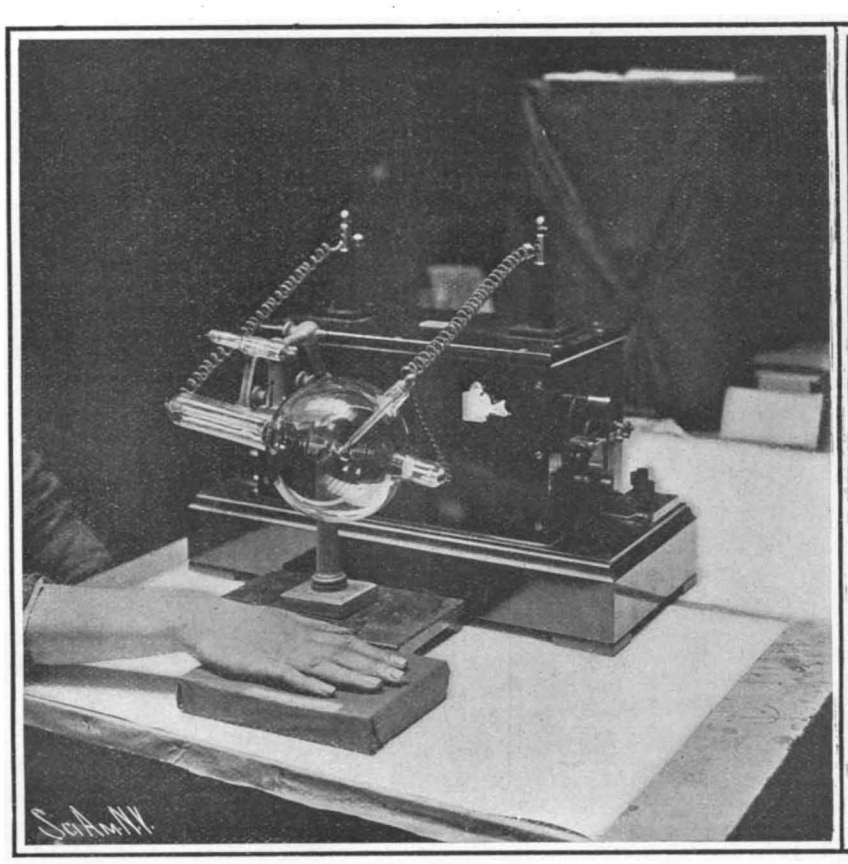
Radiographs of Hands of Persons of Various Ages.

The second and fourth pictures show the radiograph of the graduated aluminium standard; in the first and third pictures this standard and a finger joint have been cut out for photometric measurements.

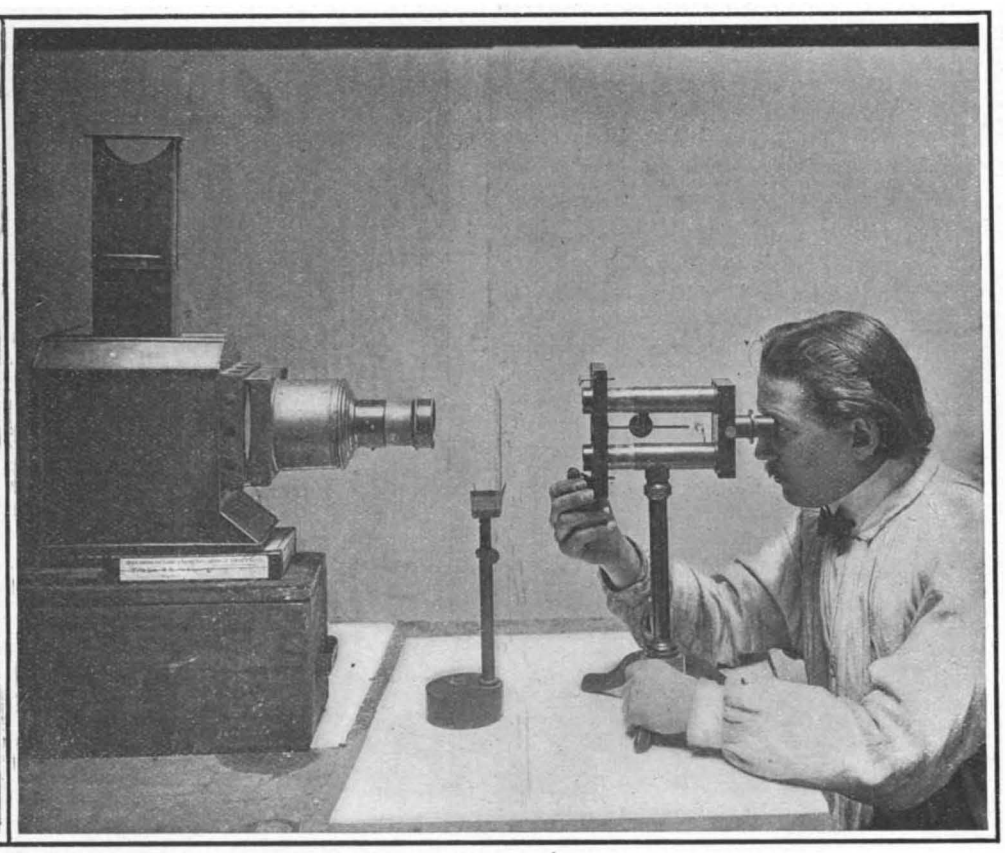
Memory of Time Exhibited by Pigeons.

M. Xavier Raspail, who has ascertained that the period of incubation of the common dove is 18 days, has seen brooding doves and pigeons abandon their nests on the 18th day, leaving eggs which showed no turbidity. M. Raspail is convinced that in these cases the female abandons the eggs because she knows that the period of incubation has expired and further brooding would be a waste of labor. If she were able to take cognizance of the absence of turbidity in the eggs she would have abandoned them at an earlier date. The common dove, although endowed with an acuteness of perception which immediately informs her that her eggs or her young have been touched by human hands during her absence from the nest, and causes her to desert them forthwith, is not able to distinguish fertile from sterile eggs, but is compelled to wait until the normal period of incubation has expired in order to be convinced of the hopelessness of her task. The hen, on the contrary, has no notion of the proper time of incubation and will, if permitted, continue to sit on infertile eggs until she is completely exhausted. This is a fresh confirmation of the law that domestication blunts the senses and faculties of animals.

Evidence of the industrial progress of Germany is given by the increase in its coal consumption which, according to the Mechanical World, increased nearly 40 per cent between 1902 and 1907. In 1907, the increase in the coal consumption over that of 1906 was 9 per cent.



Radiographing a Hand. The Aluminium Standard Lies by the Side of the Little Finger.



Measuring the Transparency of Films with D'Arsonval's Diaphragm Photometer.

THE OPACITY OF BONES TO ROENTGEN RAYS AS AN INDICATION OF AGE.

RECENTLY PATENTED INVENTIONS.

Pertaining to Apparel.

DRESSING-SACK.—L. M. ANDERSON, New York, N. Y. The invention relates to women's wearing apparel, and its object is to provide a new and improved dressing sack, which is simple in construction, ornamental in appearance and easily put on or removed whenever desired. It will fit nicely on the body, and the wearer has perfect freedom of the arms for use in any manipulations.

Electrical Devices.

GENERATOR.—K. KISHI, 1 Shiba-Kanasugi-Shinhamacho, Shiba-Ku, Tokyo, and M. NAKAMURA, 3 Shiba-Kita-Shimmonzencho, Azabu-Ku, Tokyo, Japan. The present invention relates to an electric generator, especially to an alternating current generator. Since the revolving part of high speed electric generator, such as directly coupled to steam-turbine shaft, revolves with enormous velocity, the invention pays such particular attention to the construction of coil securing device as well as field magnet of such machines, as to make them strong enough to resist the centrifugal force of these revolving parts.

SPARK-PLUG.—C. T. VAN WOERT, New York, N. Y. By means of the construction in this case it is practically impossible for oil to accumulate at the terminals of the electrodes, as both of them are so constructed as to bring about an immediate shedding or draining of the oil or liquid. Any drops which may accumulate at the annular drip edge or at the lower or bowed portion cannot in any way interfere with the passage of the spark.

DISTURBANCE-OPERATED CIRCUIT-BREAKER.—L. D. HASS and E. G. DERBIDGE, San Jose, Cal. The improvement refers to circuit-breakers, and the more particular object is to produce a type of circuit-breaker in which action while not automatic is brought about by some unusual disturbance, such, for instance, as an earthquake, a cyclone, or violent shock of an exceptional character.

Of Interest to Farmers.

CULTIVATOR.—A. C. LODWIG, Oxnard, Cal. One object of this invention is to provide a cultivator adapted for use in tilling the soil in agricultural operations, in which the knives or blades can be adjusted to adapt the cultivator for use under different conditions and in which the operator can control the knives to prevent injury to the vegetation when the cultivator is used upon fields of growing crops.

Of General Interest.

MEANS FOR VENTILATING AND EXPELLING WATER FROM MINES.—P. H. DURACK, El Paso, Tex. This inventor provides a system by means of a circulating body of fresh air, and air locks so arranged as to permit the work to be progressively carried on without interruption, allowing the mine to be developed and worked with greater safety than with the appliances heretofore used, eliminating the danger of explosion from foul air, gases, or dust, and protecting the miner day and night while the work is carried on continuously without the delays incident to blasting, etc.

SURGICAL APPLIANCE.—L. G. SCARPA, Via della Zecca N. 37, Turin, Italy. The mode of working of the devices of this appliance for the treatment of pulmonary troubles is understood when one considers that by means of the inflation of the pneumatic cushion which is maintained in contact with one of the two thoracic halves or of the basilary part of the whole thorax, in consequence of the inextensibility of the lining forming the exterior surface, the space which is occupied by the air may be gained only at expense of a depression on the whole part of the thorax which must necessarily take its position of expiration.

EYE GUARD AND SHIELD FOR SPECTACLES.—W. C. BAYLESS, Jefferson City, Tenn. The object of the invention is to provide a device which may be quickly attached to the rim of a spectacle frame that supports a lens for spectacles, be readily removed therefrom, and when in position afford a lateral guard for the eye, or if desired, a non-transparent or colored disk for covering the eye, and co-acting with the lateral guard to screen it from the light when necessary and also to protect it from dust, cold, or wind.

VENTILATOR.—A. M. H. DE BRUYCKER, New York, N. Y. The aim of this inventor is to provide a new and improved ventilator, more especially designed for use on chimneys, and arranged to insure a proper draft at all times by causing a suction in the chimney, irrespective of the wind blowing up or down in the ventilator.

ORE-CONCENTRATOR.—G. H. DAVIDSON, Morenci, Ariz. Ter. In this concentrator the material carried on an endless traveling apron is subjected intermittently to sheets of water, to allow the concentrator to move forward in a sheet undisturbed, to permit them to pass the impact line of the water undisturbed, the concentrator being washed forward by the water, and the latter being free to flow back smoothly, to produce an effective washing of the onward moving material, and hence the very fine material is not disturbed or washed away with the tailings, thus insuring a complete saving of concentrates.

ADJUSTABLE MIRROR.—B. L. HARRIS, Los Angeles, Cal. This invention pertains more particularly to mirrors such as are adapted to be supported upon the body of the user, so that the mirror will always be in position. It is adapted to be hung around the neck of the user. The device has means for adjustably holding the mirror upon the body in front of the face, so that it can be used in shaving or other similar operations.

STAMP.—B. KIAM, New Orleans, La. This invention is particularly useful in connection with hand printing stamps. The printing stamp is manually operated and has means whereby it can be identified instantly without necessitating the examination of the printing face thereof. It has a resilient body which renders the making of an impression with the stamp, easy and positive, and which carries a removable identifying card so held that both sides of the card are visible.

AQUARIUM ATTACHMENT.—H. A. ROGERS, Pagosa Junction, Col. The attachment will act to revitalize the water whereby to add to the comfort and lifetime of the occupant, rendering it practicable to keep more fish in a healthy condition in a given quantity of water than if they were compelled to subsist only upon the oxygen thrown out by the plant life employed.

Hardware.

LEVEL.—W. G. FUESSEL and F. W. FUESSEL, Hicksville, N. Y. The invention relates more particularly to levels used for determining the inclination of the horizontal, of different surfaces, and comprising a plurality of spirit tubes, one of which is annular and which encompasses a plurality of radially disposed spirit tubes, and a scale graduated in annular degrees and arranged to co-operate with the annular tube for the determination of the inclination in degrees.

WRENCH.—J. M. BOTT, Leadville, Col. The invention relates to wrenches having fixed and slidable jaws, and its object is to provide a new and improved wrench, to allow a quick and accurate adjustment of the movable jaw relative to the fixed jaw, and to securely hold the movable jaw in adjusted gripping position.

HANGER.—J. J. RONAN and J. F. BARRY, Jersey City, N. J. Although designed for general use the hanger is adapted to be used in public places, such as clubs, hotels, restaurants, and shops, and the object of the inventors is to provide a coat and hat hanger, with means for detachably holding other articles, such as canes and umbrellas.

Heating and Lighting.

HEATING AND VENTILATING SYSTEM.—H. A. WERNECKE, Manitowoc, Wis. The invention refers to certain improvements in heating and ventilating systems adapted for use in school-rooms and the like, and relates more particularly to the means for automatically establishing the desired circulation of the air, the withdrawal of the foul air, and the supplying of fresh air.

HEAT AND PRESSURE REGULATOR.—E. J. RYAN, Danville, Ill. By means of the improvement, the pressure of the water in the boiler may be maintained constantly at a predetermined amount; the pressure being restored automatically when it passes above this predetermined point or below it. The arrangement of the spiral blades on the valves provides for a turning movement of the valves whereby to provide a constant renewal of the valve surface and to prevent the lodgment of foreign surfaces between the valve and its seat.

Household Utilities.

ROUND EXTENSION-TABLE.—L. PONET, New York, N. Y. The invention has reference to furniture and the purpose is to provide a table having a top formed of a fixed centerpiece, and segmental sections, capable of being folded under the fixed center or extended flush with the latter, to increase the size of the table top.

Machines and Mechanical Devices.

BOOK TOOLING AND LETTERING PRESS.—M. KALABA, New Rochelle, N. Y. The object of this invention is to provide a machine that is adapted to readily print entire panels or combinations of characters or lettering on the rounded backs of books at a single operation, and to make the impressions even and uniform, at the same time avoiding the expense and disadvantage arising from the small tools operated by hand.

CHECK-ROW ATTACHMENT. — W. B. HAMPTON, Fremont, Mo. The invention relates to planting machinery, the more particular object being to produce a check row attachment for use in connection with a planter for the purpose of paying out or taking in a wire, as the case may be, as the planter moves along. The application is a division of one filed formerly and resulting in a patent granted to Mr. Hampton.

PIN-HOLDER.—E. W. FORNEY, Galena, Kan. In carrying out the invention a paper roll or strip in which pins are inserted and held in the usual way is coiled within a holder that is hinged, and supported by a spring in such manner that it may be depressed manually, which movement operates mechanism that advances the pin strip step by step and simultaneously projects a single pin from the top of the holder, where it may be conveniently seized and removed.

RECORDER FOR SAWMILLS.—J. W. P. BURDINE, Lake Arthur, La. The invention relates to sawmills, and its purpose is the provision of a recorder, forming a permanent feature of a sawmill, and arranged to form a permanent recorder of the amount of board measure contained in the logs sawed by the saw mill.

MACHINE FOR MAKING WOOD-CARPET SQUARES.—C. M. KREBS, New Albany, Ind. Each square is composed of wood laid edge to edge and glued onto a web of fabric, the slats for each square being formed from a single strip; and the machine being arranged to successively feed such strips to saws for cutting each strip into a plurality of slats, to stack the slats cut from one strip, to trim the side edges of the stacked slats, to feed them to an assembling device for arranging slats edgewise one alongside the other, to glue the uniting web to the assembled slats for forming a continuous piece of wood carpet, to cut the web to form individual squares, and stack them.

FEED-GEARING.—J. B. HART, Clarksburg, W. Va. In a patent formerly granted to Mr. Hart, he employed in connection with an operating rocker, an intermediate rocker arranged for operation by the operating rocker through the aid of an arm extending from the operating rocker over the intermediate rocker which carries an intermediate friction pulley operated by the operating rocker. In the present the intermediate friction pulley is carried by a rocker which is operated directly instead of through the aid of the rocker carrying the first or main friction pulley.

CONTROLLABLE POWER-TRANSMITTING MECHANISM.—E. F. JEWETT, Newtown, Ohio. This improved mechanism is adapted for use in connection with machinery of any kind in which it is desired to transmit power from a prime mover to a drive shaft, and in which it is desired to control the speed of the shaft in respect to the speed of the engine and reverse the direction of rotation of the shaft. It relates more particularly to a combined transmission gear, reversing apparatus, brakes and clutch.

Railways and Their Accessories.

MAIL-BAG CATCHER AND DELIVERER.—J. BUBB, Estabutchie, Miss. The improvement refers to the handling of mail bags, the more particular object being to provide a construction whereby mail bags may be readily delivered to or from a moving car, or in other words, exchanging mail with the car. It may be used, however, for other purposes.

RAILWAY-TIE AND CONNECTION.—G. H. SHANE and R. E. FORESMAN, Denver, Col. The object in view in this case is the provision of a metal tie possessing strength without being unduly heavy and having the requisite amount of elasticity; together with means for assembling the rails with the tie in such a manner that the gage of the track is correctly arrived at in the assemblage of parts and will permanently remain.

TRACK-RAIL FASTENER FOR RAILROADS.—J. T. WEST, Bowling Green, Ky. The purpose of the improvement is to provide for a fastener, that is readily applied for construction of a new railroad, or for repairing a track as may be required, it being adapted for quick application, and in service is very reliable and effective as a means for holding track rails secured upon cross ties of the railroad.

SWITCH.—J. L. BAILEY, St. Augustine, Fla. An object of the invention is to provide a switch for use in connection with railway lines and the like, which has movable switch points, and a swinging switch rail or frog which can be locked in a plurality of positions from the switch stand. The swinging rail or frog can be locked or closed in position to avoid pounding, hammering, and excessive wear when a train is passing over the switch.

METALLIC RAILWAY-TIE.—A. MILLER, Cape Girardeau, Mo. The object of the invention is to provide a tie, which is simple and durable in construction, cheap to manufacture, and arranged to permit of quickly and securely fastening the rails in place, and to allow convenient removal of the same whenever it is desirable to do so.

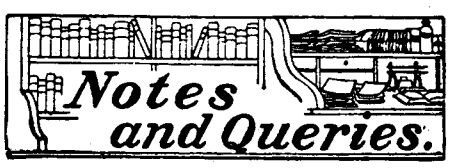
Pertaining to Vehicles.

VEHICLE.—W. N. SNOW, Snowville, N. H. One object of the inventor is to provide an efficient vehicle in which the body is resiliently mounted upon supports constituting runners, wheels, and the like, and in which the body is constantly maintained parallel to the supports, regardless of the point of the body at which the load is applied.

DUMPING-WAGON.—J. W. HOBSON, Bayonne, N. J. The invention is an improvement in dumping wagons, and the vehicle may in general respects be of ordinary construction, the novelty consisting in the construction of the body whereby to secure the dumping operation, and in the means for operating the dumping parts.

VEHICLE RUNNING-GEAR.—L. B. HART and C. I. DUPONT, Plaquemine, La. The aim of the invention is to provide details of construction for the running gear of wheeled vehicles, which will adapt the vehicle to be turned in an arc or circle of very short radius, in a perfectly safe manner, and avoid excessive friction between working parts of the running gear.

NOTE.—Copies of any of these patents will be furnished by Munn & Co. for ten cents each. Please state the name of the patentee, title of the invention, and date of this paper.



HINTS TO CORRESPONDENTS.

The full name and address must accompany all letters, or no attention will be paid thereto. This is solely for our information. *All* queries are answered by mail, and a *few* of the selected answers are afterward published in the paper. We cannot undertake to furnish information on matters of personal interest, without reasonable compensation. To answer questions which are not of general interest usually costs us from $2.00 to $3.00 each upward, and this sum should invariably be remitted in such cases. When there are questions involving building or other construction, or when calculations must be made, an estimate of the cost will be furnished upon request. We cannot give answers to examination papers, or decide wagers, nor can we undertake to solve mathematical problems of any description whatsoever. Do not use postal cards.

Queries from this vicinity not answered within fourteen days should be repeated in full. Queries from points more remote will require a longer time.

We do not make chemical analyses; but we are always pleased to give the names of minerals which are submitted to us, when it is possible for us to do so. The minerals should be sent marked distinctly with the name of the sender, and should be sent fully prepaid.

Buyers wishing to purchase any article not advertised in our columns will be supplied with the addresses of the houses manufacturing or carrying the same, as soon as possible, or if we are unable to do so, their queries can be advertised in our special classified column.

Any books on any scientific or technical subject can be furnished. We solicit requests for quotations. The SCIENTIFIC AMERICAN SUPPLEMENTS referred to are mailed for ten cents each. Book and SUPPLEMENT catalogues will be sent free on request. A careful reading of these "Hints to Correspondents" will prevent any misconception as to the uses and will prevent abuses of this column.

(10822) K. W. says: What is the composition of the compound used for making oxygen without heat, simply by pouring water on it? A. The chemical which evolves oxygen by putting water upon it is sodium peroxide. It is sold under several fancy names, but it can be bought from any dealer in chemicals. The manipulation of this process is described in Benedict's "Chemical Lecture Experiments," which we will send for $2.

(10823) E. M. H. asks: An empty 10-gallon metal air tank weighs 10 pounds. How much dead weight will be required to sink it in fresh water? Charge the same tank with 100 pounds of air, would it hold up more weight than if not charged? Could you pump the air out of the tank so that it would sink of its own weight? A. A tank of 10 gallons capacity will hold about 1 1-3 cubic feet, and when this is sunk in fresh water it will be buoyed up by a force equal to the weight of 1 1-3 cubic feet of water. This is very nearly 83 1-3 pounds. Since the tank weighs 10 pounds, an addition of 73 1-3 pounds in the tank will sink it. If 100 pounds weight of air are pumped into it, it will sink the same as if 100 pounds of lead were put into the tank. We have now 110 pounds total weight of tank and air, and 83 1-3 pounds buoyant force of water. The difference, or 26 2-3 pounds, will be the force with which it will sink. Pumping air out of the tank will make it lighter, and so it will float better. You cannot make a thing sink by pumping air out of it. Air weighs under ordinary pressure about 1 1-4 ounces per cubic foot, and 1 1-3 cubic feet will weigh 1 2-3 ounces. The tank will weigh 1 2-3 ounces less when the air is pumped out of it than it did when full of air. You cannot pump 100 pounds of air into such a tank. The pressure would be about 9,000 pounds per square inch, and no tank of this size and weight could withstand any such pressure.

(10824) A. W. D. asks: For some time I have been trying to find out what the temperature of the oxyhydrogen flame is, but have been unable to do so. Also, could you tell me if there is any other way, as by the use of a furnace, whereby a person could in the laboratory get a heat equivalent to that of the oxyhydrogen flame? A. The temperature of the oxyhydrogen flame has been variously given by different investigators, from 3,600 deg. F. to 4,400 deg. F. A recent writer gives the latter figure. The temperature of the electric arc is much higher than this, possibly reaching 7,000 deg. F. A valuable book upon this general subject is "High-Temperature Measurements," which we send for $3. The material "thermit" is considered to give a higher temperature than the oxyhydrogen flame.

(10825) W. F. asks: Would you please tell me what the liquid is, that is used in the instrument described in your issue of December 31, 1904, SCIENTIFIC AMERICAN, for detecting positive or negative poles in any source? Would the receipt in Query No. 7,484 be all right to use in the tube? A. The solution given in Query 7,484 would work in a tube for a polarity indicator; but the following is better, and is used in all the indicators on the market now: Dissolve 15 grains of phenolphthalein in 1 ounce alcohol. Dissolve 20 grains of sodium sulphate in a pint of water, and add the alcohol solution to this. You will have enough to fill hundreds of tubes. The negative pole turns red with this indicator, and upon shaking up the liquid the color disappears, and the tube may be used indefinitely.

NEW BOOKS, ETC.

HYDRAULICS OF RIVERS, WEIRS, AND SLUICES. The Derivation of New and More Accurate Formulæ for Discharge through Rivers and Canals Obstructed by Weirs, Sluices, etc., According to the Principles of Gustav Ritter von Wex. By David A. Molitor, C.E., Mem. Am. Soc. C.E., Designing Engineer Isthmian Canal Commission, etc. New York: J. Wiley & Sons. London: Chapman & Hall, Ltd., 1908. 8vo.; cloth; illustrated; 135 pages. Price, $2 net.

The production of a treatise of the caliber needed to fill the neglected field of river hydraulics is due to the engineering zeal and experience of Mr. Molitor. To the theories of Von Wex is given a book that is the latest technical authority on water power development. With scientific care, mathematical accuracy and literary clearness, the principles of the "Hydrodamik," Von Wex's remarkable work, are wrought into practical chapters on overfall weirs; sluice weirs and sluice gates; backwater conditions; flow in rivers and canals; and empiric coefficients. By this publication, the status of the mechanics of fluids may no longer be considered as unsatisfactory. The presentation of the "new formulæ" is a technical achievement of immense interest and importance to progressive engineers. In the appendix there is a paper "On the Flow Over a Flight of Panama Canal Locks," and also a tabulation of the new formulæ arranged for ready reference. The illustrations are in the form of diagrams.

INSOMNIA AND NERVE STRAIN. By Henry S. Upson, M.D., Professor of Diseases of the Nervous System in the Western Reserve University, Attending Neurologist to the Lakeside Hospital, Cleveland, Ohio. With Skiagraphic Illustrations. New York and London: G. P. Putnam's Sons, The Knickerbocker Press, 1908. 12mo.; cloth; 142 pages. Price, $1.50.

In this little volume on mania, dementia, and melancholia, the author's argument is strengthened by confirmatory evidence to show that the nerve strain generally associated with sleeplessness is neither degenerate nor incurable. Of the most direct causes of the more obscure cases of nervous and mental derangements, the teeth are the most important. A large section is given to the discussion of dental diseases and these are almost of universal occurrence, often painless and localized only by skiagraphy.

REINFORCED CONCRETE. A Manual of Practice. By Erhest McCullough, M.W.S. E., Civil Engineer. Chicago: Cement Era Publishing Company, 1908. 12mo.; cloth; 128 pages; illustrated. Price, $1.

The service in this book is adequate for the requirements of all manner of work that does not call for the use of the larger standard treatises on reinforced concrete. Even at this restriction, the ground covered needed the experience of a highly practical engineer, one who instructs in a way that leaves the student advancing into the art of designing and constructing greater structures, nothing to unlearn. The manual is timely, as nothing in the building industry needs a good one more than the subject chosen. The chapters are on Strength of Beams, Loads on Beams, Columns, Walls, Tanks and Footings, Design and Cost, Forms, The Conduct of Work, Tools. These are illustrated with numerous diagrams.

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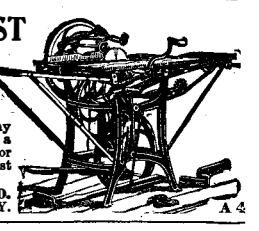

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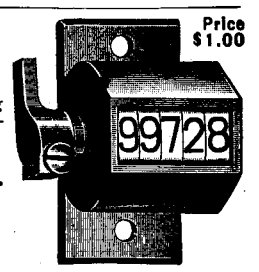

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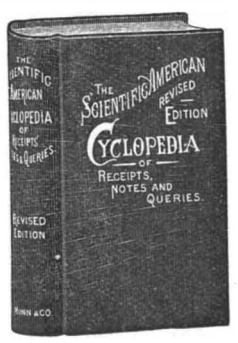

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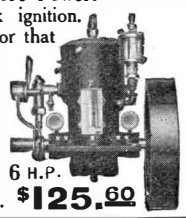

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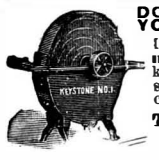

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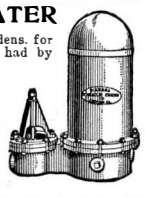

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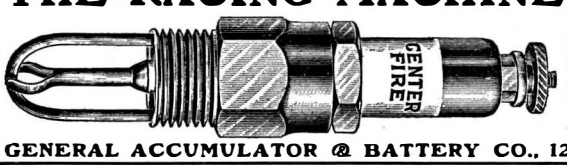

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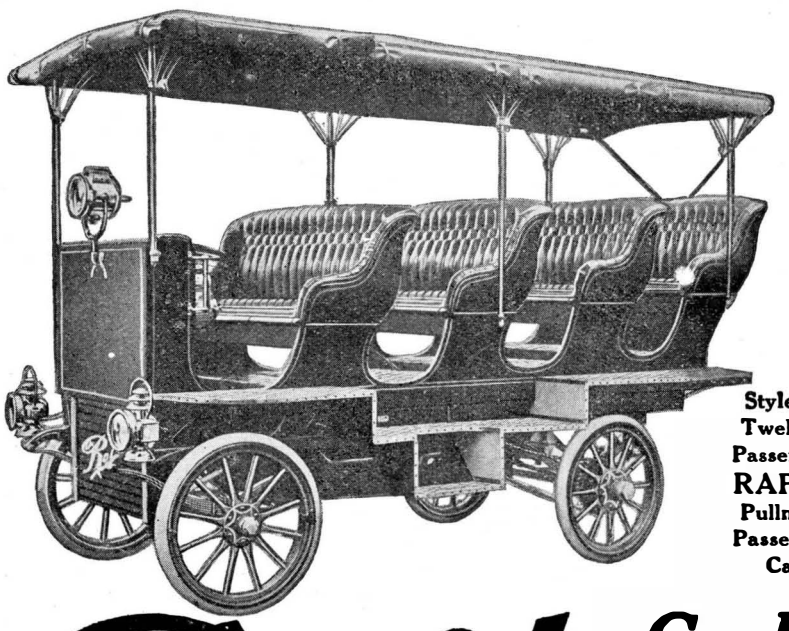

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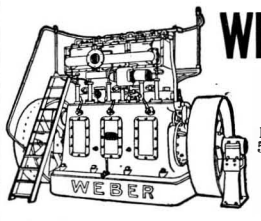

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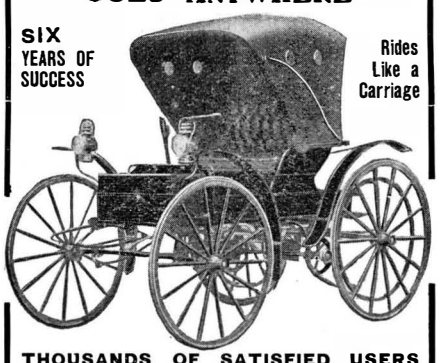

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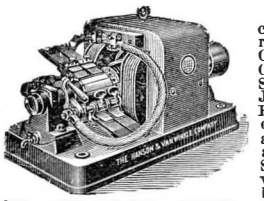

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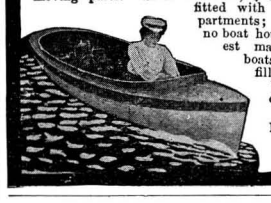

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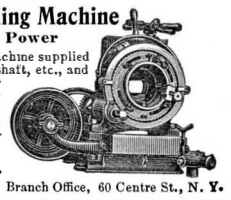

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